INTERNATIONAL JOURNAL OF RESEARCH & METHODOLOGY IN SOCIAL SCIENCE
VOL. 5, NO. 1 | JAN. – MAR., 2019 | QUARTERLY JOURNAL | ISSN 2415-0371

Scientia, Fortitudo & Victoria

QUARTERLY JOURNAL
ISSN 2415-0371
Vol. 5 No. 1

Peer
Reviewed
Scientific Journal
in Social Science

OPEN ACCESS

Berlin Declaration of Open Access to Knowledge in the Science and Humanities
Budapest Open Access Initiatives
The Cape Town Open Education Declaration

INTERNATIONAL JOURNAL OF RESEARCH & METHODOLOGY IN SOCIAL SCIENCE
QUARTERLY & PEER REVIEWED
ISSN 2415 0371
PQ

ISSN 2415-0371
9 772415 037100

ONLINE & OPEN ACCESS
www.socialsciencepublication.com

BOAD OF EDITORS

INTERNATIONAL JOURNAL OF RESEARCH & METHODOLOGY IN SOCIAL SCIENCE is a peer reviewed scientific journal in social science and its interdisciplinary fields. The journal is published quarterly. The Boards of Editors oversee the acquisition, review, and publication of quarterly research papers in social science. Editorial inquiries may be sent by email directly.
Editor@socialsciencepublication.com
EditorIJRMSS@gmail.com.

OFFICE OF THE EDITOR-IN-CHIEF
International Journal of Research & Methodology in Social Science (IJRMSS)
55 / 123 Rangsit-Nakhon Nayok Rd.
T. Lampakkood, A. Thanyaburi
Pathumtanee, THAILAND 12110
Email1: Editor@socialsciencepublication.com
Email2: EditorIJRMSS@gmail.com
Website: www.socialsciencepublication.com

International Journal of Research & Methodology in Social Science
Vol. 5, No. 1, p.iii (Jan. – Mar. 2019). ISSN 2415-0371 (online)
www.socialsciencepublication.com; DOI: 10.5281/zenodo.2667563

TABLE OF CONTENT

International Journal of Research & Methodology in Social Science
Vol. 5, No. 1, p.1 (Jan. – Mar. 2019). ISSN 2415-0371 (online)
www.socialsciencepublication.com; DOI: 10.5281/zenodo.2667563

Risk of autism in the use of assisted reproduction techniques: *An analysis from the Transcurssive Logic*

Dante Roberto Salatino★ - Alberto E. Tersoglio★★

About the authors

★Dante Roberto Salatino is a researcher of the Institute of Philosophy and of the Institute of Linguistics - Lecturer in the General Psychology Department – Lecturer in the Philosophical Aspects of Physical-Mathematical Science Department - Faculty of Philosophy and Letters - Teacher and Researcher in Artificial Intelligence in the Mechatronics Career - Faculty of Engineering - National University of Cuyo, Mendoza, Argentina - Email for correspondence: dantesalatino@gmail.com

★★Alberto E. Tersoglio: Founder, and Director of the International Assisted Reproduction Center, Mendoza, Argentina. Email for correspondence: tersoglioa@gmail.com

ABSTRACT

This paper investigates the existence of a relationship between assisted reproductive technology (ART), such as intracytoplasmic sperm injection (ICSI) and the birth of autistic children. Based on abundant bibliography (Danan et al, 1999; Cummins, 2000; Riva & Giorgi, 2000; Palmen, 2004; Allen, 2005; Tavano et al, 2007; Palmieri & Persico, 2010; Bolduc et al., 2011, 2012; Stoodley et al., 2012; Konopka, 2013; Lyall et al, 2013; Sandin et al, 2013; Chen et al., 2015; Fountain et al., 2015; Siddiqui et al., 2016; Punamäki et al, 2016; Liu et al, 2017; Babinská et al, 2017; Griffiths & Levy, 2017; Liang et al., 2017) propose that the possibility of transference of paternal mitochondrial DNA through these techniques is a determining factor to be taken into account in the alteration of Ca^{++} homeostasis that has been detected in some autistic patients. This condition would facilitate, according to the theory of psychic functioning (Salatino, 2013, 2016), the cancellation of low frequencies (20 Hz) in the brain, which manage the sociocultural system. If we add to this the decrease in the cerebellar Purkinje cells that are usually found in patients with autism, it would explain the alterations of the psychic structure and function that produce deterioration or lack of language and social treatment shown by these patients. Taking Hempel's nomological-deductive method as a guide and complementing it with transcurssive logic, a reasonable explanation can be given to the following hypothetical case: after the use of the ICSI technique, an autistic child was born. Since this technique gives the possibility that part of the paternal mitochondrial DNA, contained in the sperm, passes to the ovule upon fertilization, and produce a case de paternal heteroplasmy. By reviewing the aforementioned etiological aspects, we were able to predict the appearance of the psychic disorders of these children, taking into account structural and functional aspects of the psychic apparatus, with firm neurobiological bases. The hypothetical case analyzed justifies paternal heteroplasmy as one of the possible causes of autism, according to some of the statistics presented by other authors.

Keyword: autism spectrum disorder (ASD), assisted reproduction techniques, psychic disorders, scientific explanation, transcurssive logic.

CITATION:

Salatino, D. R.; Tersoglio, A. E. (2019). "Risk of Autism in the use of assisted reproduction techniques. An analysis from the Transcurssive Logic" *Inter. J. Res. Methodol. Soc. Sci.*, Vol., 5, No. 1: pp. 1-16. (Jan. – Mar. 2019); ISSN: 2415-0371.

1.0 INTRODUCTION

Autism is a disorder of neuropsychic development that with a practical purpose, we will characterize only through two of its relevant clinical aspects: lack of language development and lack of social functioning leads, in addition to a deterioration of the socio-communicative behavior, to the appearance of repetitive and restrictive behaviors (Konopka, 2013).

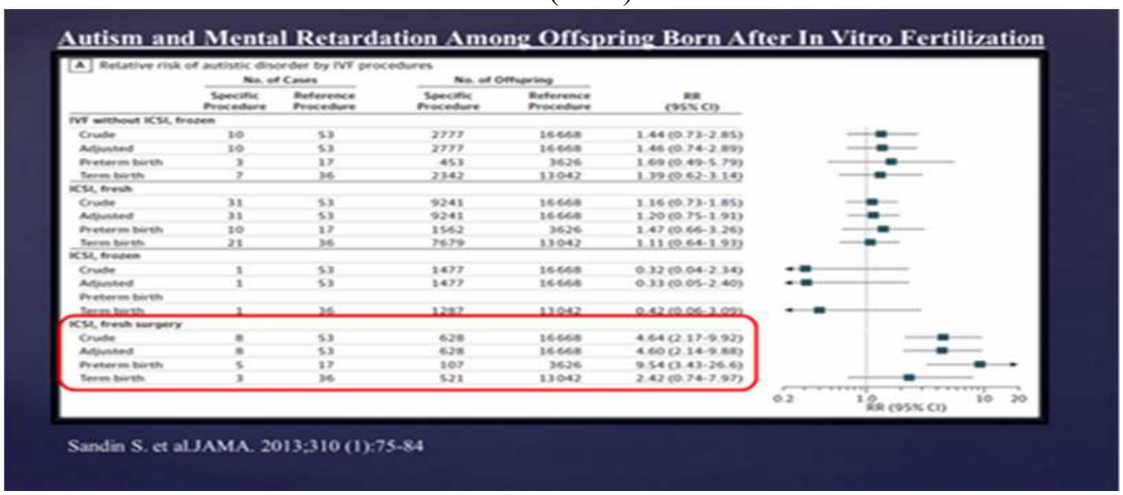
From a specific theory of psychic structure and functioning (Salatino, 2013, 2016), the previous findings can be explained. This theory proposes that the psychic apparatus is responsible for managing subjective reality, that is, the subject's own, which is constituted by three real systems: 1) *Bio-external system* (responsible for maintaining life and perpetuate it), 2) *Psycho-internal system* (which is responsible for achieving proper adaptation to the immediate environment), and 3) *Sociocultural system* (ready to adjust relationships with our peers).

In this work, we investigate the significant relationship detected between the technique of assisted reproduction of intracytoplasmic sperm injection (ICSI), among others and the birth of autistic children. We propose that the possibility of transference of paternal mitochondrial DNA (See Appendix A) through this technique, perhaps associated with failures in the mechanism of mitochondrial elimination of the ovule, is a strong determinant of the alteration in Ca ++ homeostasis that has been detected in some autistic patients. This condition would facilitate, according to the theory of psychic functioning mentioned, the cancellation of low frequencies (20 Hz) in the brain, which are the ones that manage the sociocultural system. If we add to this the decrease in the cerebellar Purkinje cells that are usually found in patients with autism, it would explain the alterations of the psychic structure and function that produce deterioration or lack of language and social treatment.

2.0 ANTECEDENTS

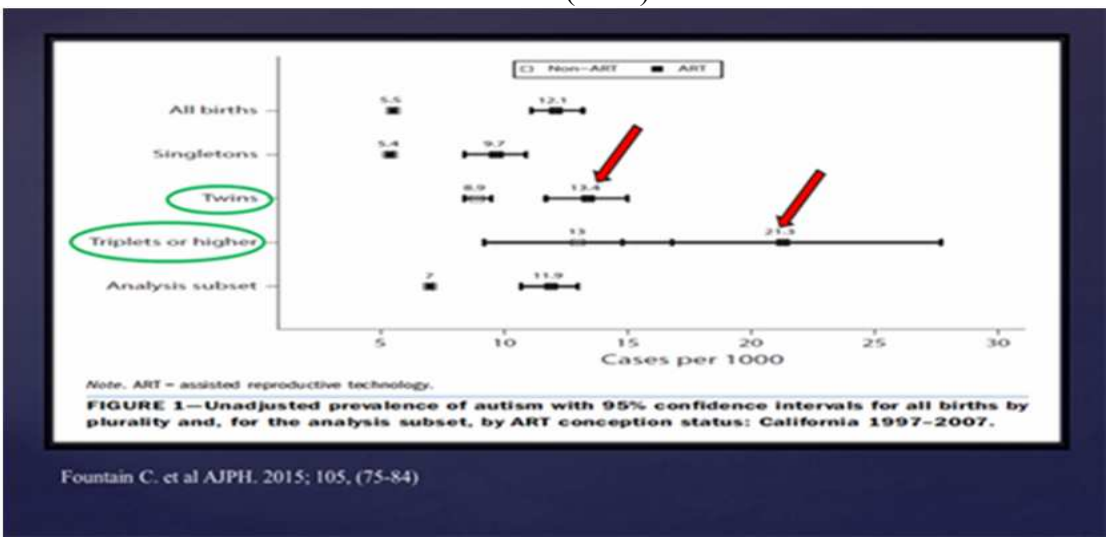
Sandin *et al.* (2013) showed that in 2.5 million children born between 1982 and 2007, 30,959 (1.2%) were conceived through IVF. In general, 103 of 6959 children (1.5%) with autistic disorder and 180 of 15,830 (1.1%) with mental retardation, were conceived by IVF. Therefore, the RR for ASD after any procedure compared to spontaneous conception was 1.14% (95% CI, 1.01-1.36: 46.3 vs. 39.8 per 100,000 persons/year). Comparing IVF without ICSI with fresh embryo transfer, there was a statistically significant increase in the risk of ASD, followed by ICSI using surgical sperm extraction and fresh embryos. (RR, 4.60 [95% CI, 2.14-9.88]; 135.7 vs. 29.3 per 100,000 persons per year). They conclude that the use of specific procedures, IVF with ICSI, for paternal infertility was associated with a small (though significant) increase in RR for ASD and mental retardation compared to IVF without ICSI. (Table I).

Table 1. Extracted and modified of Sandin *et al.* (2013)



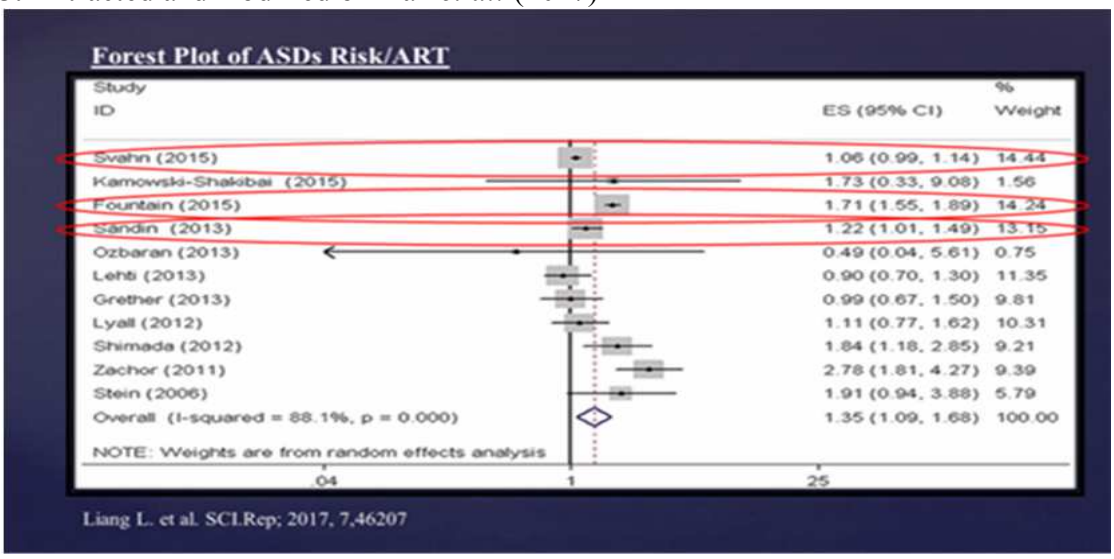
Fountain et al. (2015), studying children born in California, between 1997 and 2007, showed that in the general population, the incidence of the diagnosis of autism was double in births using ART, that in spontaneous births. This incidence was more noticeable and was directly related to the fact of multiple births (twins, triplets), something very common in cases where ART is used (Table II).

Table 2. Extracted and modified of Fountain *et al*. (2015)



Liang *et al.* (2017) evaluated the risk of ASD in offspring obtained through ART, in a meta-analysis. A bibliographic search was performed in PubMed, Embase, and Web of Knowledge databases until April 30, 2016, to identify all relevant records. Risk indices (RR) and 95% confidence intervals (95% CI) were calculated to analyze the strength of association by using fixed or random effects models based on the heterogeneity test in subgroup analyzes and totals. The analysis of the total of 11 registers (3 cohort studies and 8 case-control studies) revealed that the use of ART is associated with a higher percentage of ASD (RR = 1.35, 95% CI: 1.09- 1.68, P = 0.007). Also, subgroup analyzes were performed based on the study design, study location, and study quality, and some subgroups also showed a statistically significant association. This study indicated that the use of ART could be associated with an increased risk of ASD in the offspring. However, more prospective, large and high-quality studies are still required (Table III).

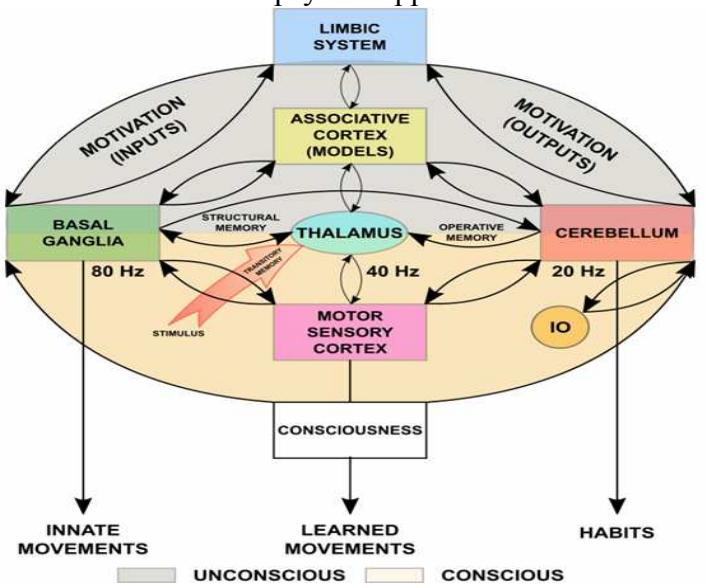
Table 3. Extracted and modified of Lian *et al.* (2017)



3.0 PSYCHIC APPARATUS

The proposed structure of the psychic apparatus is based on the anatomy, physiology, and neurobiology of the central nervous system (CNS) (Figure 1).As can be seen in the diagram, there are six gray structures of the CNS, which are involved in the constitution and management of the psychic apparatus. These structures are: 1) Thalamus, 2) Basal ganglia, 3) Limbic system, 4) Cerebral cortex (associative and sensorimotor), 5) Cerebellum, and 6) Inferior olive (IO).The stimuli that arrive, both from the social environment (socio-cultural system), as well as from the immediate environment (psycho-internal system) and even from the organism itself (bio-external system), enter through the sensory pathways, to the thalamus (set of gray nuclei) , located in the center of the brain mass). From there, they are derived to the basal ganglia (a group of gray nuclei that are at the base of the brain) that are responsible for "identification" the entries. This "identification" does nothing but determine from what real system the stimulus comes, so that our psyche can elaborate the appropriate response. The input information remains momentarily, retained in the "transient memory," which is located in the cerebral cortex. If the stimuli come from the bio-external system (of our body), their solution has absolute priority; it is the basal ganglia themselves that promote the immediate response through a series of innate, unconscious movements.

Fig. 1. Neurobiological fundamentals of the psychic apparatus



On the other hand, if the stimuli come from the immediate environment (psycho-internal system) or the social environment (sociocultural system), the basal ganglia, together with the limbic system (arranged around the corpus callosum, the structure that connects both hemispheres), they give the motivational framework to the entrance. Although the basal ganglia are what determine whether the new stimuli are "known" or not. When we already "know" the answer, that is, when we have already made a "habit" of responding in the same way to the same requirements, the basal ganglia "consult" the associative cerebral cortex (prefrontal cortex, located fore of the sensorimotor cortex).), to see if there is an antecedent of this situation. If this antecedent exists, they give the order to execute the known motor response. This "anticipated response" is "recorded" in the cortex of the cerebellum (posterior part of the brain), which we know as "operative memory."

Something very different happens when the challenge posed by incoming stimuli has no antecedents. Consciousness is involved for the first time since it is a new situation, of which we must have an apprenticeship, some experience. On this occasion, the stimuli received by the

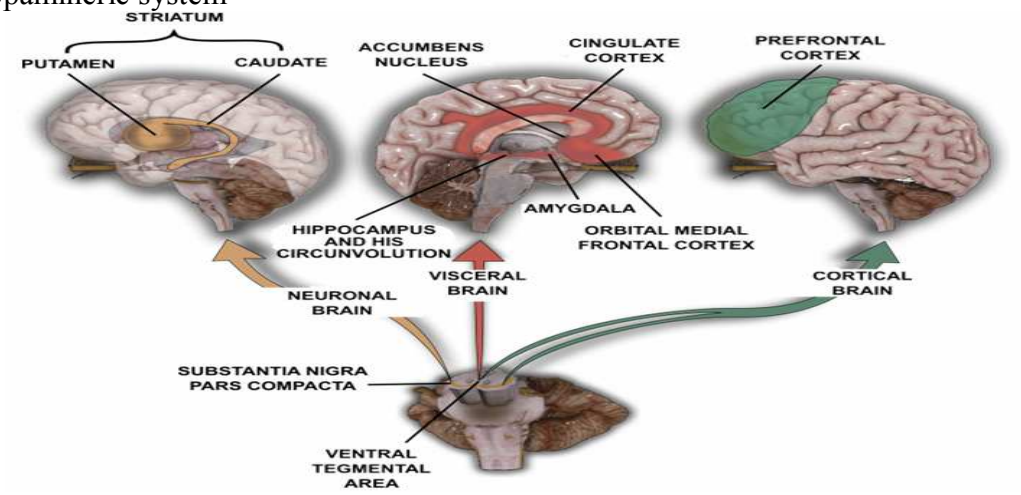
thalamus are derived to the basal ganglia for their "identification" and their "classification" (process that we will deal with in detail, later), once it is verified that there is no history of the present situation, the limbic system assigns an important emotional charge, because it is unknown. Produced the "classification" of the stimuli, which indicates to the psychic apparatus the relevance of the aspects that determine the real fact perceived, according to their order of precedence, are sent to the thalamocortical circuit (thalamus-associative cortex). This circuit is responsible, in the first place, for temporarily "contextualizing" the perceptive act. This meticulous process is carried out by the specific nuclei (that contemplate what comes from outside the psyche) and the non-specific nuclei (which do the same with what emerges from the subject) of the thalamus. In the second place, the thalamocortical circuit records the fact of having learned, and, therefore, of having achieved a certain knowledge and an understanding of the new reality, will become part of the "psychic structure" of the subject. This "structure" will be housed in the "structural memory," that, which residing in the cerebral cortex, is indelible and unconscious.

When the registration of a new event was confirmed, the basal ganglia, the limbic system, the cerebellum and the inferior olive (gray nucleus belonging to the medulla oblongata, which is located at the upper end of the spinal cord), combine the corresponding adaptive response, with the due emotional tenor. This response or these "learned movements," at least in the first times they occur, are of a conscious nature. Then, if they are repeated often and successfully, they will become part of a habit that is of unconscious nature.

4.0 IDENTIFICATION AND CLASSIFICATION OF STIMULUS

Phylogenetic evidence shows us a CNS with a tripartite neuroanatomical architecture related to the organization of behavior (movement and other behaviors) (Salatino, 2012) (Figure 2). According to evolutionary antiquity, and only for didactic purposes, we can identify each of these parts as 1) neuronal brain where the psychic structure depends only on the functioning of the neurons and the structures that support it are the brainstem (formed by the midbrain, the pons and the medulla oblongata) and the basal ganglia; 2) visceral brain that sits in the limbic system that are the neural networks from which arise the affections that structure the psyche; and 3) cortical brain whose sustenance is the cerebral cortex in its maximum development degree which allows the human being, and only him, to achieve a psychic structure (neuronal arrangements) that enable the management of the cognitive phenomenon as the supreme manifestation of his subjectivity.

Fig. 2. Dopamineric system



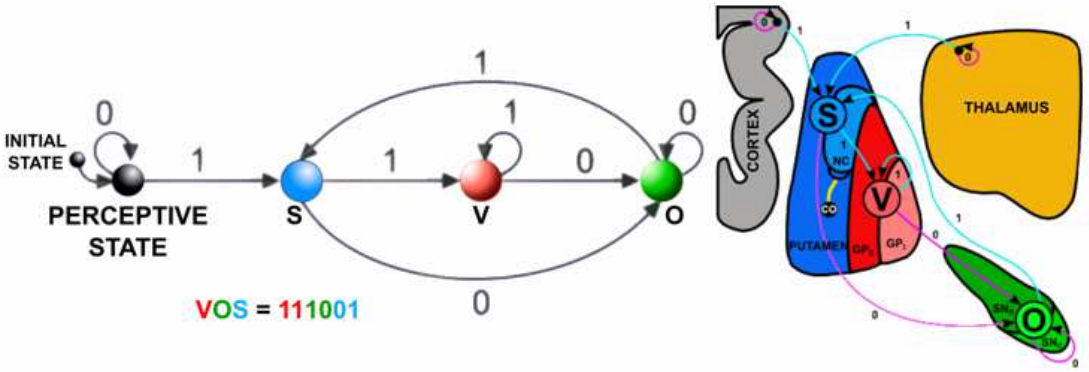
Dopamine is a neurotransmitter that is present in different areas of the CNS and is very important in the regulation of the motor activity of the organism, that is, in the projection of the response in cognition, in motivation, in milk production, in sleep, in humor, in attention, and in learning. In other words, it is dopamine that puts into function the different strata of the psychic

structure described according to the real system (Salatino, 2009) that must be attended to; that is, the biological or bio-external (neuronal brain), the psychic or psycho-internal (visceral brain), or the sociocultural (cortical brain).

Dopamine is what defines, what structures are part of each of these 'evolutionary brains', but the intimate mechanism that allows the selection of one of them according to the real system to which attention has to be paid is of a nature temporary, since each one is guided by a "neurological pacemaker". The three pacemakers have a base frequency that identifies them, as follows: the pacemaker of the basal ganglia (perception) oscillates at approximately 80 Hz, the thalamocortical pacemaker (psychic structure) at 40 Hz and the olivocerebellar pacemaker (movement) at approximately 20 Hz The Ca ++ ion is the main determinant of these frequency bands.

On the other hand, for the "classification" of the stimuli, we propose a supposed perceptual unit based on the logical mechanism of a "finite automaton" (Figure 3). From the Transcurssive Logic (TL) we characterize, in a very general way, a real event like the concurrence of a subject (S = 01), an object (O = 10) and a transformation (V = 11) that binds them. The composition of this detector is very simple. It consists of an "identifier" for each of the "elements" that makes up a real event and a series of connectors, which, when interpreting its binary code, allows the system to change its status.

Fig. 3. Deterministic finite automaton – generic perceptive apparatus



References: NC: caudate nucleus - CO: cholinergic interneuron - GA: GABAergic interneuron GP_E: external globus pallidus - GP_I: internal globus pallidus - SN_R: Pars reticulata substantiae nigrae SN_c: Pars compacta substantiae nigrae - 1: activation - 0: inhibition - S: subject - O: object; V: transformation

The "perceptive machine" above can identify any of the six patterns that are formed with the three elements indicated. That is, SVO, VOS, OSV, SOV, OVS, and VSO. To identify to which real system belongs the "fact" we perceive, we use the first element of the "chain." For example, the VOS pattern that is placed in the previous figure comes from the real sociocultural system. Equivalently, if the pattern begins with "S," the phenomenon to be analyzed comes from the psycho-internal system or from what has to do with the subjectivity of living beings. Whereas if the first element is "O," it is telling us that the real fact has to do directly with our body, or with something external to us, but that it has no life.

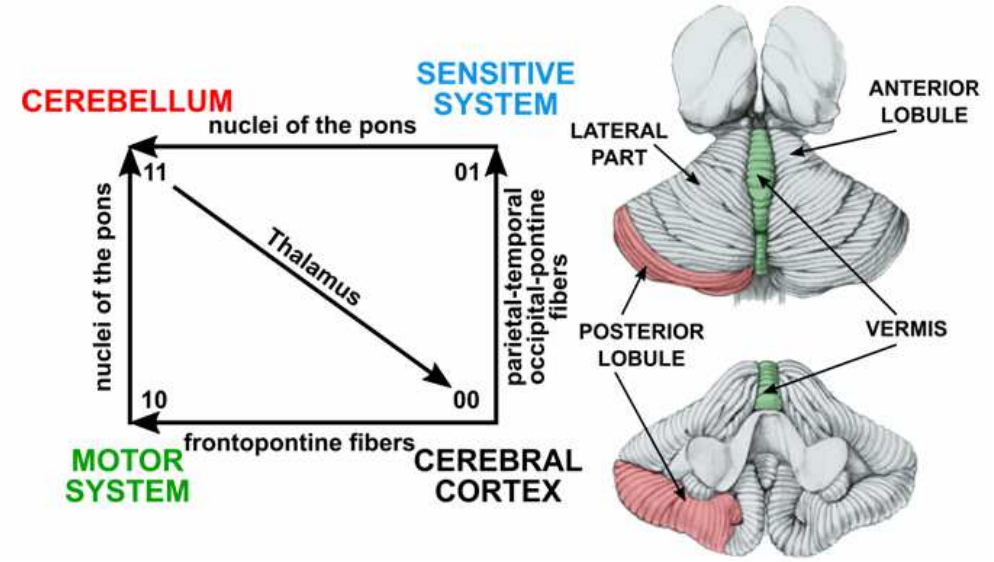
Once the origin, or the system to which the stimulus belongs, is identified, we must "classify" it. The latter is achieved by identifying the elements that follow the first. In the case of the example of the figure, the fact is identified as coming from the sociocultural system (a transformation) and prioritizes the "object" that was the destination of that transformation, rather than the "subject" that was its producer. In the same way, we proceed with the remaining five patterns. In the same figure, we can see the "center of operations" of the perceptual system, represented by the basal ganglia, where the finite automaton has been superimposed. In the scheme,

the activating (1) and inhibitory (0) connections between them and with the thalamus and the cerebral cortex have been respected (Salatino, 2014, p.42).

5.0 AUTISM NEUROBIOLOGY

From the neurological point of view, in general, autism is seen as a disorder of connectivity between different parts of the CNS. The cerebellum is at the crossroads between the sensory and motor systems, so it is essential for communication between both (Figure 4).

Fig. 4. PAU of the cerebro-cerebellar loop



The PAU of Figure 4 shows the anatomical connections of the cerebellum to the brain through the thalamus. We see that the cerebral cortex is connected to the motor system, using the frontopontine fibers while it does with the sensitive system, through the parietal-temporal-occipital pontine fibers. In turn, both systems are connected to the cerebellum through the nuclei of the pons. The cerebellar-cerebellar loop is closed using the thalamus (Becker & Stoodley, 2013, p.4). Although the cerebellum is one of the first structures of the human brain to develop, it is not fully mature until after the first postnatal years (Ibídem, p.5). This is essential to explain why "conventional language" begins to develop after 18 months (Salatino, 2012, p 245). There are important investigations that relate the malformations of cerebellar vermis (🔴) with autism (Bolduc *et al.*, 2011, 2012; Tavano *et al.*, 2007). While malformations of the cerebellar lobes are associated with selective deficits of the executing function, for example, language or "spatial cognition." The latter is very important because it reflects the patterns of cerebellar connectivity. Language difficulties are associated with lesions of the posterolateral lobule (🟢) (Riva & Giorgi, 2000; Stoodley *et al.,* 2012). In addition to the cerebellum, in autism are involved: the cerebral cortex, the thalamus and the striatum (basal ganglia).

5.1. HYSTOPATHOLOGICAL AND FUNCTIONAL CHANGES

The most consistent of the histological changes found in autism cases is the loss of cerebellar Purkinje cells, particularly from the lobes. (Allen, 2005; Palmen, 2004). A reduction in cerebellar activity (such as that found in autism) is accompanied by an increase in the activity of the cerebral cortex, in particular, of the prefrontal regions (Mostofsky et al., 2009; Takarae *et al.*, 2007). It suggests that the autistic "psychic problem" is not only structural, as we believed, but also functional. In other words, it may have basic patterns of behavior, but, socially, it cannot project them into adequate conduct.

The interruption of GABAergic inhibition in Purkinje cells can influence the functioning in thalamocortical circuits. It has been suggested that the reduced function of Purkinje cells produces

reduced cerebellar modulation of dopamine release in the medial prefrontal cortex (Rogers *et al*., 2013). It is possible that the loss of Purkinje cells ultimately leads to an imbalance of the excitation/inhibition ratio in the cortex, which is hypothesized to be an underlying mechanism of ASD (Maloney, 2013).

6.0 PSYCHIC ALTERATIONS

The most important manifestations that characterize the autistic child do not derive from pathology in itself but a different psychic disposition. The autistic psyche presents, as seen by the Transcursive Logic, marked modifications concerning what we have proposed above as a standard psyche. Such modifications, at least in the case presented in this work, are of genetic origin and, therefore, congenital.

The autistic child, literally, "lives in another world." Another is the subjective reality that sustains it, others and very different are its vital and different priorities will be then, the contributions required from the surrounding environment.

For the autistic, the social world either does not exist or if it exists it is only a rudiment that cannot be accessed because it lacks the possibility of using conventional language appropriately.

Aid programs established as suitable to deal with these children should contemplate at their base: social reintegration techniques structured on their real needs and not, like most of them, trying to 'provide' supposed pragmatic solutions for the correct use of language and in a derivative way, a "better structuring" of their thinking. The latter respond to the prejudices on which the cognitive sciences are based, which are the current frame of reference for most of the institutions dedicated to helping autistic people.

Therefore, we will not consider the alleged role of cognitions in information processing, nor will we adhere to one of the major axioms of cognitive science, which states: cognitive processes (ideas, beliefs, rules). They translate external and internal events into representations or structures of meaning (Chappa, 2003, p.98).

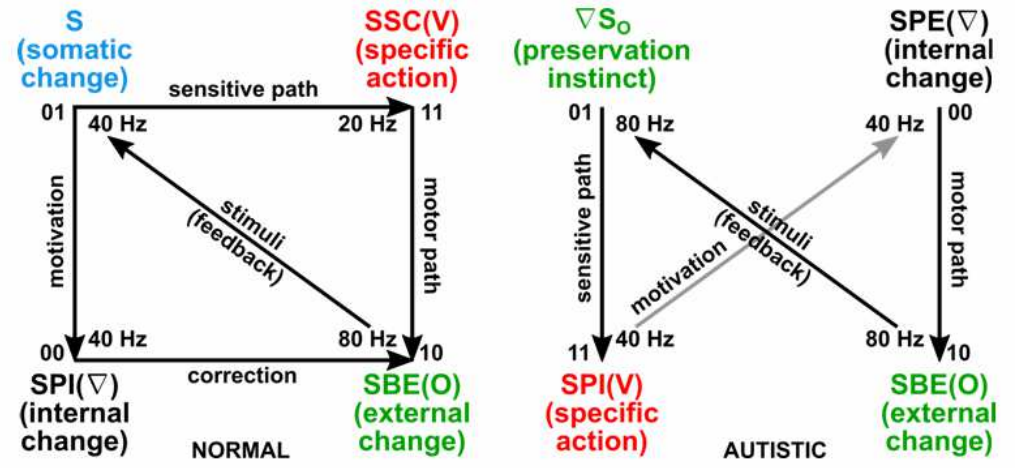
In this work, we are going to show a possible origin of the autistic "asociality," to call it in some way. To be more precise, an autistic person is not "asocial," in the strict sense since "asocial" is an individual (or social subject) who does not identify himself consciously or intentionally with the social group in which he is immersed. The autistic, on the other hand, never becomes an individual, that is, never becomes a social subject. His individuality is pure subjectivity, and as such, it has no possibility of identification with his group.

An autistic person also does not suffer from *anomie* (See Appendix B), that is, from inappropriate social behavior due to not observing the established norms. For the autistic, social norms lack meaning and the true reason for this; we should look for it in the causes that leads to its apparent 'affective anesthesia' since affection is the only socializing means of the human being.

As we have already seen in another work (Salatino, 2012), at the fundamental level, psychic structuring is based on the administration of change. The marked resistance to change evidenced by all children with autistic disorders is well known. Since we have proposed that the psyche of the autistic is not abnormal but different, it is clear then that the change is not what relates subject and object in his psyche. A direct consequence of the above is its manifest difficulty in learning the sociocultural norms that are arranged according to the dominant majority. That is, it is not possible to characterize the changes that beset his psyche. Then, the key is to be able to determine what binds the basic constituents of your psyche, that is, subject and object. Or better yet are the elements that structure your psyche subject and object? Or do you only handle related objects not because of the change, but because of the static ligatures perceived between them in the first instance? If this were so, obviously their PAUs should have another provision and not to mention their structural and operative memories.

Let's start with the psychic PAU. It is evident that by not acknowledging the external change given its apparent perceptual indifference, the only manifestation that promotes the evolution of the psychic structure is the internal change. To clarify the above, let's see Figure 5.

Fig. 5. PAU of the autistic Psyche



References: S: subject – O: object – V: apparent transformation - ∇: non-apparent transformation. SBE: bio-external system – SSC: sociocultural system – SPI: psycho-internal system. SPE: psycho-external system - ∇SO: objective subject

In the left part of Figure 5, in a structural PAU, we see the differentiation of the original change that structure, usually, the psyche. The relationship between a somatic change (01) that generates a vital urgency (hunger) is appreciated. An external change corrects the previous imbalance (10) (maternal contribution).

Finally, a change represented by a specific action in response to external change (11) (suction). This sequence is evident or superficial. At a deep level, there is part of the original change (internal change) (00) that fulfills the function of linking and functionalizing the other changes. It is that change that is not evident except for its unmistakable manifestations. Those that are apparently allow the alternation between the other changes or the predominance of one over another, until achieving the motivation that promotes the satisfaction of the original desire. The subjective reality then arises from the conjunction of a desire and a need that must be satisfied. In the scheme, the different real systems that "administer" the described changes have been superimposed, with their respective neurobiological activations (the different frequency ranges that we have already seen) and the different processes that connect them.

In autism, on the other hand, (Figure 5, right) it is as if the desire did not exist, that is, the memory of a satisfying experience is not shown at the superficial level (01). The voluntary, non-inherited impulse that moves to live does not arise; only an involuntary and inherited need or impulse is present, useful to preserve life (00). Given the above, the psychic PAU of the autistic is structured as follows: 1) The somatic change (01) is replaced by one of the instances in which the internal change (∇) unfolds, which becomes superficial and evident (∇So (01)). The subject (S) is replaced by an "objective subject." 2) The other instance of internal change (∇), converted into a kind of "psycho-external system" (SPE∇ (00)), replaces specific action (V), which has now become deep (SPIV (11)), and represented the specific action (V), which has now become deep (**SPIV (11)**), and represented the specific response to drive the external change, that appears as help to cover the vital need. The external change (**SBE (10)**) is not modified.

The described modifications configure a bicyclic PAU, where an internal change ends up related to an external change through another internal change. Which is equivalent to two objects related by an internal change. The first instance of internal change becomes "objective subject." The external change, the one that contributes to settle the vital need, will replace the "objective object." While the second instance of internal change will replace the specific action, acting as a means to

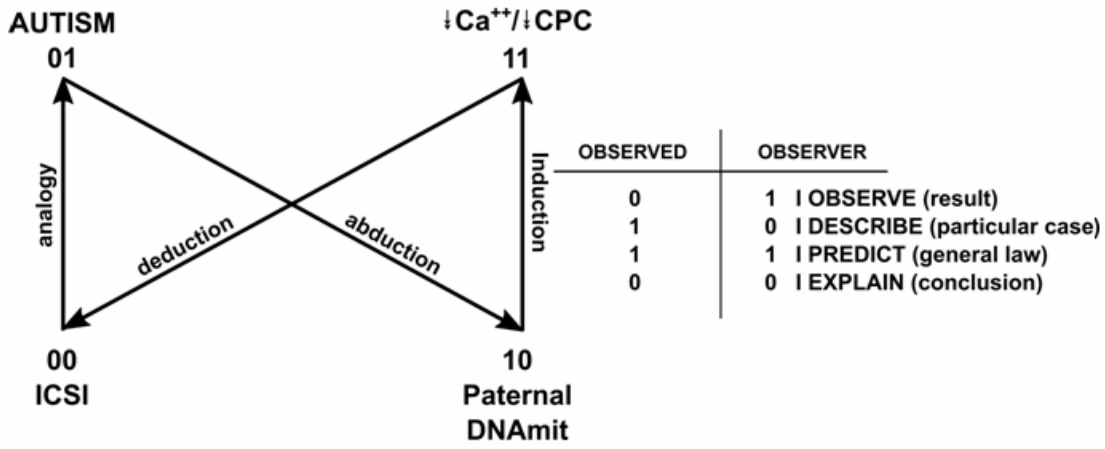
interrelate the two previous changes, and is the one that will put into operation the reflection of suction, crying and later, more complex acts, that is, replace the objective change (**Vo**) that normally relates subject and object.

We observe in the autistic scheme the superposition of the systems that manage the proposed changes, and as can be seen, the frequency range of the 20 Hz is missing, which is the one that handles the projection of our behavior, as a conduct, to the sociocultural system and depends on the neuronal brain and the olive-cerebellar circuit. This "social disconnection" explains, in part, the clinical findings in autistics, where a kind of "inward motivation" is evident as the subject tacitly disappears.

7.0 HYPOTHESIS

Figure 6 shows the hypothetical situation in which, after the application of the ICSI technique of assisted reproduction, an autistic child is born. Assumption based on the evidence provided by several studies (Danan *et al*., 1999, Cummins, 2000, Lyall *et al*., 2013, Sandin *et al*., 2013, Punamäki *et al.,* 2016, Liu *et al.,* 2017). Assuming the possibility that part of the paternal mitochondrial DNA contained in the sperm passes to the ovule upon fertilization, given the procedure used to achieve sperm immobility (see Appendix A), I can describe the particular case. That is, it is assumed that the presence of paternal mitochondrial DNA can produce autism (Palmieri & Persico, 2010, Chen *et al*., 2015, Siddiqui et al., 2016, Babinská *et al.,* 2017, Griffiths & Levy, 2017). By invoking a universal pattern (PAU) as a general law, we can predict some structural and functional alterations of the cerebellum, such as, for example, alteration of Ca ++ homeostasis, or a significant decrease in the population of Purkinje cells in the cerebellar cortex (Riva & Giorgi, 2000, Palmen, 2004, Allen, 2005, Tavano et al, 2007, Bolduc *et al.,* 2011, 2012, Stoodley *et al*., 2012, Konopka, 2013). According to all the above, I can conclude that, in this hypothetical case, a possible explanation for the birth of a child with autistic disorder is in the use of the method of assisted fertilization ICSI or similar.

Fig. 6. Explanatory PAU



8.0 CONCLUSION

We reviewed some etiological aspects of autism, including alterations at the level of the cerebellar cortex and in the homeostasis of Ca^{++} in association with mitochondrial diseases, and made predictions about some of the supposed psychic alterations that an autistic child presents. These psychic alterations justify the classic capital symptoms of autism, through a theory of psychic structure and function, with firm neurobiological bases. The hypothetical case of the birth of an autistic child is considered after the application of the ICSI technique of assisted reproduction, in which the generation of a mitochondrial pathology could be involved, due to heteroplasmy of paternal origin.

REFERENCES

Allen, G. (2005). "The cerebellum in autism." *Clinical Neuropsychiatry*, **2**(6), pp. 321–337.

Babinská, K. et al. (2017). "What is the evidence of mitochondrial dysfunction in Autism spectrum disorders?" *Activitas Nervosa Superior Rediviva*, Volume 59, Nº 2.

Becker, E. B. E.; Stoodley, C. J. (2013). "Autism Spectrum Disorder and the Cerebellum." In "The Neurobiology of Autism". R. Adron Harris and Peter Jenner (Editors). Volume 113, Massachusetts, Elsevier Inc.

Bolduc, M. E., Du Plessis, A. J., Sullivan, N., Khwaja, O. S., Zhang, X., Barnes, K., *et al*. (2011). "Spectrum of neurodevelopmental disabilities in children with cerebellar malformations." *Developmental Medicine and Child Neurology*, **53**(5), pp. 409–416.

Bolduc, M. E., du Plessis, A. J., Sullivan, N., Guizard, N., Zhang, X., Robertson, R. L., *et al.* (2012). "Regional cerebellar volumes predict functional outcome in children with cerebellar malformations." *Cerebellum*, **11**(2), pp. 531–542.

Bromham, L.; *et al.* (2003). "Mitochondrial Steve: paternal inheritance of mitochondria in humans." *TRENDS in Ecology and Evolution*, Vol. 18, Nº 1, pp. 1-3.

Chappa, H. J. (2003). "Distimia y otras depresiones crónicas. Tratamiento psicofarmacológico y cognitivo social" - Buenos Aires, Ed. *Médica Panamericana*.

Chen, S. *et al.* (2015). "Elevated mitochondrial DNA copy number in peripheral blood cells is associated with childhood Autism." *BMC Psychiatry*, **15**:50.

Cummins, J. M. (2000). "Fertilization and elimination of the paternal mitochondrial genome." *Human Reproduction*, Vol. 15, (Suppl. 2), pp. 92-101.

Danan, C. et al. (1999). "Evaluation of Parental Mitochondrial in Neonates Born after Intracytoplasmic Sperm Injection." *Am. J. Hum. Genet.*, **65**, pp. 463-473.

Dhillon, S.; Hellings, J. A.; Butler, M. G. (2011). "Genetics and Mitochondrial Abnormalities in Autism Spectrum Disorders: A Review." *Current Genomics*, **12**, pp. 322-332.

Gardner, D. K.; Simón, C. (2017). *Handbook of In Vitro Fertilization*. New York, CRC Press.

Griffiths, K. K.; Levy, R. J. (2017). "Evidence of Mitochondrial Dysfunction in Autism: Biochemical Links, Genetic-Based Associations, and Non-Energy-Related Mechanisms." *Oxidative Medicine and Cellular Longevity*, Volume 2017, Article ID 4314025, 12 pages.

Jiménez, L. F.; Merchant, H. (2003). *Biología celular y molecular*. México, Pearson Educación.

Konopka, G. (2013). "The Neurobiology of Autism: Integrating Genetics, Brain Development, Behavior, and the Environment." *International Review of Neurobiology*, Volume 113, Massachusetts, Elsevier Inc.

Liu, L. et al. (2017*). "*Association between Assisted reproductive technology and the risk of Autism spectrum disorders in the offspring: a meta-analysis." *Scientific Reports*, **7**, Article number: 46207.

Lyall, K. et al. (2013). "Infertility and Its Treatments in Association with Autism Spectrum Disorders: A Review and Results from the CHARGE Study." *Int. J. Environ. Res. Public Health*, **10**, pp. 3715-3734.

Maloney, S. E. *et al*. (2013). *Identifying Essential Cell Types and Circuits in Autism Spectrum Disorders*. En The Neurobiology of Autism, Editores: R. Adron Harris & Peter Jenner, pp. 61-96.

Palermo, G.; Joris, H.; Devroey, P.; Van Steirteghem, A.C. (1992). *Pregnancies after intracytoplasmic injection of single spermatozoon into an oocyte*. Lancet, 340(8810), pp. 17–8.

Palermo, G. D.; Sills, E. S. (2018). *Intracytoplasmic Sperm Injection. Indications, Techniques and Applications*. New York, Springer.

Palmen, S. J. M. C. (2004). *Neuropathological findings in autism*. Brain, 127(12), pp. 2572–2583.

Palmieri, L.; Persico, A. M. (2010). *Mitochondrial dysfunction in Autism spectrum disorders: Cause or effect?* Biochimica et Biophysica Acta 1797, pp. 1130-1137.

Punamäki, R-L. et al. (2016). *Mental health and Developmental outcomes for children born after ART: a comparative prospective study on child gender and treatment type*. Human Reproduction, Vol. 31, Nº I, pp. 100-107.

Riva, D., & Giorgi, C. (2000). *The cerebellum contributes to higher functions during development: Evidence from a series of children surgically treated for posterior fossa tumours*. Brain, 123(Pt. 5), pp. 1051–1061.

Rogers, T. D.; Dickson, P. E.; McKimm, E.; Heck, D. H., Goldowitz, D.; Blaha, C. D. et al. (2013). *Reorganization of circuits underlying cerebellar modulation of prefrontal cortical dopamine in mouse models of autism spectrum disorder*. Cerebellum, **12**(4), 547–556.

Salatino, D. R. (2012). *Aspectos psico-bio-socioculturales del lenguaje natural humano. Introducción a la teoría psíquica del lenguaje* - Mendoza, Argentina - Desktop Publishing, Amazon, ISBN: 978-987-33-2379-9.

Salatino, D. R. (2014). *Psyche – Structure and Function* – Mendoza, Argentina – Autoedición. ISBN: 978-987-33-5702-2.

Salatino, D. R. (2016). *Procesos Cognitivos. Fundamentos Neurofisiológicos. Una teoría del funcionamiento psíquico* – Mendoza – Argentina, Autoedición – ISBN: 978-987-42-2038-7.

Sandin, S. et al. (2013). *Autism and Mental Retardation Among Offspring Born After In Vitro Fertilization*. JAMA, 310(1), pp. 75-84.

Siddiqui, M. F.; Elwell, C.; Johnson, M. H. (2016). *Mitochondrial Dysfunction in Autism Spectrum Disorders*. Autism Open Access, **6**(5). doi:10.4172/2165-7890.1000190.

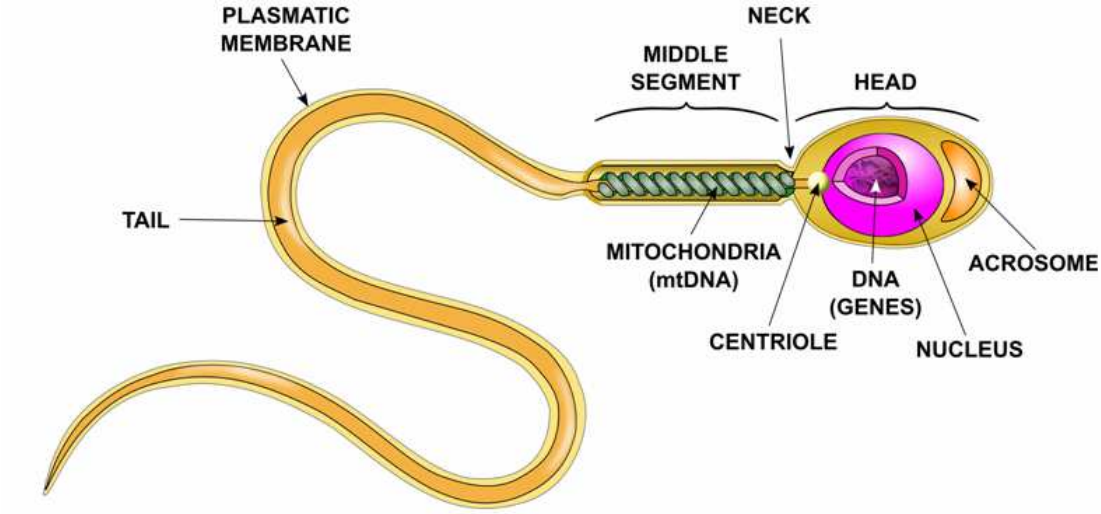
Stoodley, C. J., MacMore, J., Makris, N., Sherman, J. C., & Schmahmann, J. D. (2012). *Preliminary voxel-based lesion-symptom mapping in cerebellar stroke patients: Motor vs. cognitive outcomes*. In: Paper presented at the Society for Neuroscience Annual Meeting, New Orleans, LA.

Tavano, A., Grasso, R., Gagliardi, C., Triulzi, F., Bresolin, N., Fabbro, F., et al. (2007). *Disorders of cognitive and affective development in cerebellar malformations*. Brain, **130**, pp. 2646–2660.

International Journal of Research & Methodology in Social Science
Vol. 5, No. 1, p.13 (Jan. – Mar. 2019). ISSN 2415-0371 (online)
www.socialsciencepublication.com; DOI: 10.5281/zenodo.2667563

APPENDIX A
ASSISTED FERTILIZATION THROUGH INTRACYTOPLASMIC SPERM INJECTION (ICSI)

Since the successful birth of Louise Brown in 1978, in vitro fertilization has been the method of choice to treat infertility. The results obtained by the traditional technique of in vitro fertilization were inconsistent in the presence of infertility due to mild male disorders, but very poor when the malefactor was important (azoospermia, oligozoospermia, asthenozoospermia, etc.). Given these results, a new insemination technique was used: microinjection (Gardner & Simón, 2017). The first pregnancy, followed by live birth, after using ICSI was reported by Palermo in 1992. There are other indications for the use of ICSI, when the malefactor is not at stake, for example, previous failure of an in vitro fertilization, immature oocytes, etc. (Palermo, 2018).



The spermatozoon is the haploid cell (with 23 chromosomes) that constitutes the male gamete. In human fertilization, is who gives sex to the egg or zygote. They are pyriform cells composed of three parts: 1) Head, 2) Middle segment, and 3) The flagellum or tail, which gives it its mobility. In turn, the head contains two parts: the acrosome formed by enzymes that favor the rupture of the zona pellucida surrounding the ovule, to achieve fertilization. And the nucleus, which contains its genetic load in the DNA divided into 23 genes. Once the acrosome opens the zona pellucida of the ovule, the nucleus is the only part of the sperm that penetrates its cytoplasm to fuse with its nucleus and form the diploid cell (with 46 chromosomes) that represents the zygote.

As for the middle segment, it is a zone of 4 or 5 µm in length that has a large number of mitochondria (mitochondrial DNA), which give the centriole energy to move the tail and thus can progress through the neck, the uterus, and the fallopian tubes until reaching the ovule to fertilize it (Jiménez & Merchant, 2003, p.680). The ICSI technique consists of the following stages (Palermo & Sills, 2018, p. 14):

1) Preparation of the ICSI plate: there are nine drops of the medium used for the injection, one central and eight in a radial form, covered by cultivation oil. This plate is stored at 37 ° C until use.

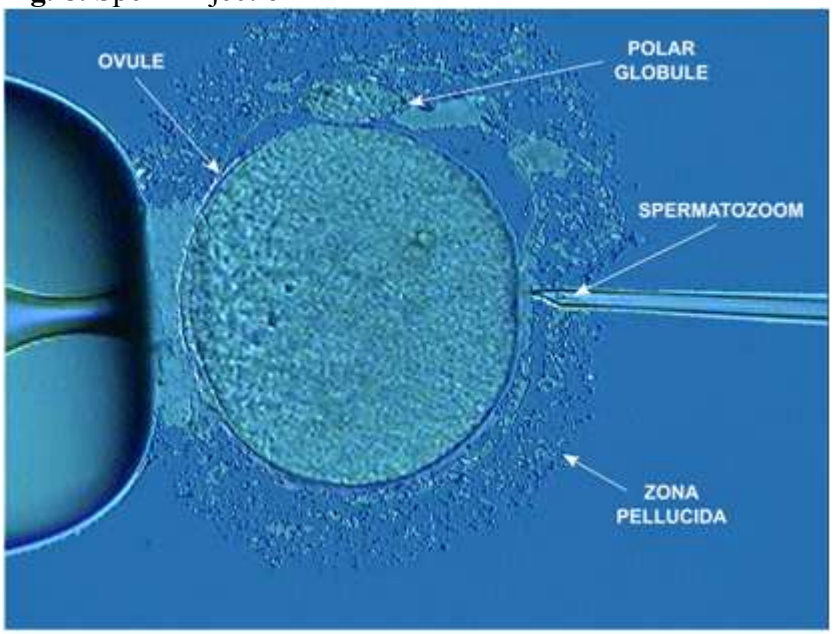
2) Loading of gametes: immediately after the injection of sperm the central drop is removed and replaced by a diluted suspension of sperm. In the other drops, the oocytes are placed.

3) Immobilization of sperm: a single sperm is selected from the drop of sperm from the ICSI dish (usually the central drop) and aspirated at the tip of the injection pipette after immobilizing it, breaking the tail by pushing it with the pipette injection against the bottom of the Petri dish. If the initial attempts at immobilization are not successful, it is repeated until the tail is twisted and broken. [It is important to note that, given the technique described, it is possible for the

mitochondria of the middle segment to enter the ovule, in addition to the nucleus, providing paternal extranuclear DNA.]

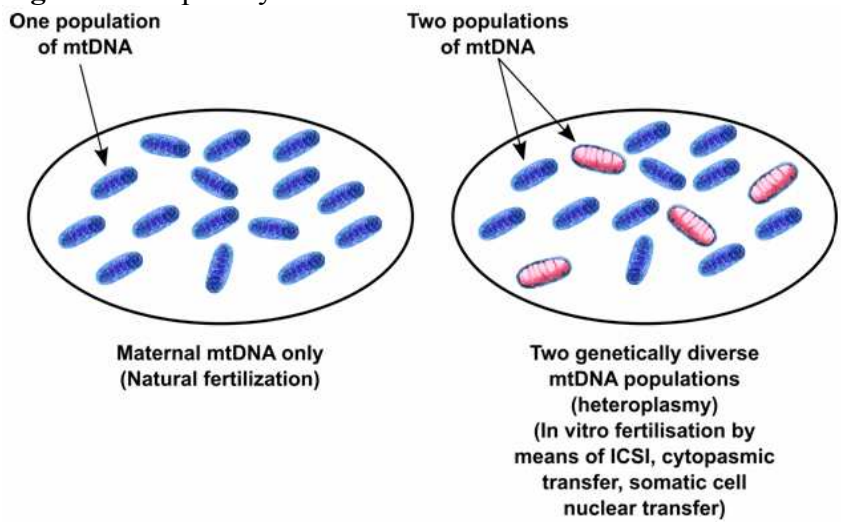
4) Sperm injection: once the oocyte is located inside the drop, it is kept in place by a retention pipette, to locate the polar body. The injection pipette focuses on the right edge in the equatorial plane at 3 o'clock. The sperm is placed near the bevel of the injection pipette. With it, is pressed at 9 o'clock until breaking the ovular membrane. Then the sperm is expelled (Figure 8).

Fig. 8. Sperm injection



HETEROPLASMY

Fig. 9. Heteroplasmy



In normal fertilization, the mitochondria of sperm origin occur in a ratio of 1: 1000 concerning the mitochondria of the oocyte, which could be the result of a dilution process (Ankel-Simons and Cummin, 1996). This assumption was incorrect since the incorporation of mitochondria in mammalian ooplasm during fertilization was demonstrated (Sutovsky *et al.,* 1996).

AUTOPHAGY

In fertilization, the mitochondria taken to the cytoplasm of the oocyte by the sperm are searched and destroyed, leaving only the mitochondria of the oocytes to propagate their mitochondrial DNA to

the offspring. This mode of clonal inheritance, the paradigm of "mitochondrial Eve" is mediated by a proteolytic resident in the oocyte.

The machinery for the degradation of proteins and organelles is based on the ubiquitination of the sperm mitochondria within the cytoplasm of the fertilized oocyte, producing autophagy.

When a lucky sperm cell fuses with the ovum, between 100 and 200 paternal mitochondria enter the ovule at the time of fertilization, which is largely surpassed by the 100,000 mitochondria derived from the mother.

In theory, as fertilization occurs, the paternal mitochondria must be destroyed. Perhaps, due to a failure of the destructive mechanism or, because the sperm comes from a testicular puncture where immature forms are taken, that destruction is not carried out.

Mitochondria inadvertently damage their own DNA through the production of free radicals of oxygen and other metabolic contaminants. This could mean a problem if the gamete uses its own mitochondria during fertilization since it could damage the mitochondrial genome that must pass to the zygote (Bromham, L. et al. 2003).

APPENDIX B

Anomie: It should not be confused with the neuropsychological disorder that affects some aphasics, characterized by the difficulty to remember the name of things.

Frontopontine fibers: are situated in the medial zone of the base of the cerebral peduncles; they arise from the cells of the frontal lobe and end in the nuclei of the pons.

Heteroplasmy: is the presence of more than one type of organellar genome (mitochondrial DNA) within a cell or individual.

International Journal of Research & Methodology in Social Science
Vol. 5, No. 1, p.17 (Jan. – Mar. 2019). ISSN 2415-0371 (online)
www.socialsciencepublication.com; DOI: 10.5281/zenodo.2667563

The Mind and Mental Faculties

Part 1 of 2

Louangrath, Paul T.I.★

About the author

★Louangrath, P.I. is an Assistant Professor in Business Administration at Bangkok University, Bangkok, Thailand. For correspondence, he could be reached by email at: Lecturepedia@gmail.com

ABSTRACT

This paper explains mental faculties under Buddhist theory of the mind. Buddhism classified mental faculties according to their positive, negative and neutral effect. We used the negative mental faculties or *mentis malus* to help diagnose stress and depression. *Mentis malus* consists of 5 types mental malevolence and together has 14 components. Individually and severally, these 14 components of the dark side of the mind contribute to a state of unhappiness. The level of unhappiness or mental problem that people experience depends on the level and numbers of *mentis malus* surfacing in their consciousness. There are two parts to this paper. In this part 1 installment, we outlined the working of the mind through 50 distinct mental faculties that give rise to human emotions. In Part 2, we will provide an analysis of 14 mental faculties or types of emotion that give rise to stress. By having pinpointed the cause of stress, we offer non-invasive and non-chemical dependent tool for stress management and preventative measures against depression.

Keywords: cetasika, consciousness, depression, emotion, mental faculties, mind, stress

CITATION:

Louangrath, P. I. (2019). "The Mind and Mental Faculties;" part 1 of 2 parts. *Inter. J. Res. Methodol. Soc. Sci.*, Vol., 5, No. 1: pp. 17-51. (Jan. – Mar. 2019); ISSN: 2415-0371.

1.0 INTRODUCTION

The purpose of this paper is to explain mental faculties. We define mental faculties as the ability of the mind to accomplish a certain mental tasks. These tasks are formation of emotions. Emotions are mental states. These mental tasks are defined and categorized into 52 components. These 52 components of mental faculties function contemporaneously with the mind. The mind represents consciousness. The emotions of the mental faculties depend on consciousness for its existence, and expression. We identified 14 mental faculties or mental states which contribute to stress and depression. Effective stress management depends on the recognition and avoidance of these 14 mental states.

Mental faculties are categorized into two main groups: general and occasional. The general emotional state may be experienced by everyone. Occasional emotional state may be experienced by an individual only in specific occasion upon certain stimuli. The general unwholesome mental states consist of 4 elements: *Moha (Delusion or ignorance); Ahirika (Shamelessness); Anottappa (Moral fearlessness);* and *Uddhacca (Restlessness)*. The remaining ten occasional unwholesome emotions include are divided into three subgroups: (i) greed category which include *Lobha (Greed);*

Diṭṭhi (Wrong view); and *Māna (Conceit)*; (ii) hate category which include *Dosa (Hatred); Issā (Envy); Macchariya (Stinginess);* and *Kukkucca (Worry, remorse)*; and (iii) hinderance category which include Thīna (Sloth, laziness); Middha (Torpor, tiredness); and Vicikicchā (Skeptical doubt). The scope of this paper is to explain all 52 types of human emotions, and focus on the 14 types of emotion that cause stress and depression.

Table 1. Unwholesome or unhealthy mental states

General unhealthy mental states	Specific unhealthy mental states
There are 4 general unhealthy mental states: -Delusion, ignorance or confidence (*Moha*) -Shamelessness (*Ahirika*) -Moral fearlessness (*Anottappa*) -Restlessness (*Uddgacca*)	There are 10 specific unhealthy mental states: (i) Greed category: -Greed (*Lobha*) -Wrong view (*Diṭṭhi*) -Conceit (*Māna*) (ii) Hate category: -Hatred (*Dosa*) -Envy (*Issā*) -Stinginess (*Macchariya*) -Worry, remorse (*Kukkucca*) (iii) Hinderance category: -Slothfulness, laziness (*Thīna*) -Torpor, tiredness (*Middha*) -Skepticism, doubt (*Vicikicchā*)

Both the mind and mental faculties are abstract. Their existence has no material or organic representation. Neither the mind nor mental faculties has an organ. We may point to the brain as the organ that processes information or external stimuli. The physical organ called brain is a separate entity which mind and consciousness depends; however, the outward and observable existence of the mind is a distinct and separate entity from the physical organ. Personality, for instance, is one aspect of the outward manifestation of the mind, but it cannot be said that it is a brain because a brain is an organ, but personality is a pattern of behavior and thoughts. We use the bodily organs to process external stimuli to formulate meaning, make judgment or evaluation. The mind is consciousness or a state of awareness where external stimuli are processed through the six senses: hearing, seeing, smelling, tasting, touching, and cognition (*mentis*).

Although the scope of this paper is to explore mental faculties, it is not possible to disregard the discussion of the mind because the existence of mental faculties depends on the mind. Therefore, by introducing the subject matter, we explain the role of the mind before embarking on exploring mental faculties.

This paper employs English as the language of the text. However, certain terms are in *Pali*, a language that the Tipitaka was originally written (Stargardt, 2000). Tipitaka is the teaching of Buddha contained in 45 volumes of texts. The Tipitaka talks about the mind and its function. *Pali* is the Middle Indo-Aryan language native to the Indian subcontinent. Original *Pali* terms are used to refer to the original terms or vocabularies used to describe the nature, function and characteristics of the mind and mental faculties. The English translation of these terms could not do justice to the accuracy of the term without losing its original meaning; thus, Latin is used to supplement the English translation of the *Pali* terms. The definitions of some of these terms appear in the appendix. Some modern Thai language text is used to supplement the explanation in the footnote.

1.1 The mind

Mental faculties are functional aspects of the mind. Therefore, it is of prime importance that we first introduce the mind. The mind is defined as a state of consciousness. The mind does not have a form, it is an abstract. As a state of consciousness, the mind indicates a state of awakening, awareness, and cognition. This state depends on a living being. A non-living object of an unanimated object does not have a mind; a mind exists only in a living being.

The mind is the mental faculties that are non-physical (Clark, 2014). The non-physical description of the mind as the working of the physical organ, brain, is considered an older view. Modernly, the mind is viewed as "physical" to include the brain organ and its activities and functions (Smart, 2011). Some studies of artificial intelligence uses the working of the mind to model mental phenomena of the human mind (Klopf, 1975). The dichotomy of physical and non physical classification of the mind is artificial and erroneous. The "mind" refers to the working or function of the brain organ upon the receipt, processing, and interpreting stimuli through the organ senses: ear, eyes, nose, tongue, body and mental contact. It is a phenomenon that is abstract. Its work and function may be observed, but the "mind" itself is not. Whatever physical forms that writers tried to use to attach meaning to as the mind are nothing more than evidence of the existence of the mind. The "physical" manifestation of the mind is the evidence of the function of the mind, and, therefore, is its existence. As for the mind itself, there is no organ. Even though modern science may claim that the brain represents all thinking process or mental work of a living being, this narrow view of the mind is inadequate for deeper discussion of understanding of the mind since science could only explain how the brain works through indirect evidence, such as electroencephalograph measuring electrical impulses emitted by the brain organ and infer that the brain is working and, therefore, that is the evidence of the mind. No machine has the capability of pinpointing what "thought" is processed by the mind. Since no such machine exists, empirical evidence seeking to prove the existence of the mind through physical evidence is futile. The physical brain organ has 86 billion neurons and each is linked to 10,000 other neurons (Wishaw and Ian, 2010; Sherwood, 2011). This knowledge does not prove or define what is the mind? The evidence only shows the composition or constituents of the brain organ.

The lack of modern research to understand the mind and its function also tell us that the western concept of mind is in adequate. There had been attempts to argue that only intellectual function, such as reasoning constitutes the mind (Başarm 2010). For some writers, the mind is equivalent to "thought" (Israel and North, 2010).

As an abstract, the mind should be seen and studied independently of the physical body or organ, such as the brain (Kim 1995). Independent, not in a sense that there is a physical body and the mind is an independent abstract, such as the soul or spirit that comes and goes from the physical body (Delgado, 1969), but as an independent condition of knowing or cognition. This approach to the mind transcends the realm of academic inquiry to the world of superstition.

Western philosophy of dualism taught that the mind is independent properties that emerge from the brain, but cannot be reduced to the brain itself; at the same time, it is not a distinct substance (Hart, 1996). This attempt to explain the mind is a good dance around the fire without explaining "what is the fire?"

The discussion of the mind makes neuroscience look, more or less, like a fake science because it uses scientific instrument to measure or prove an abstraction. Abstract is concept; as such it is non-material. Scientific measurements are nothing more than evidence of the working of the brain organ. Even for the function of the brain itself, these measurements are nothing more than the evidence of traces of the function or an organ, but not the organ itself. Only inferences could be made; it is only by the acceptance of the general supposition of the inference, that the scientific community accepts these measurements as scientific evidence; but evidence of what? The mind as we have explained is an abstract, not form. A tree with a height of 3 meters is a form that could be measured by a meter stick. However, the life of a tree may not be measured directly. We may say that a tree have existed for ten years and conclude that the life of a tree is ten years old. The length

of time of ten years is no more different than an electroencephalograph measuring the electrical impulses of the brain and concludes that the graph represents the measurement of the mind. This scientific failure in empiricism is evident in western literature.

From the older western trace of the study of the mind, Plato himself understood the dualism of form as material object and mental images as abstract. However, through the course of history, advances of western science had lost its way in understanding the dichotomy of form and abstract. Spinoza, for instance, for the lack of understanding of the mind had attributed the mind to "nature" and "God" (Spinoza, 1670). Modern writers are more logical to admit that the understanding of the mind cannot be limited to physical science (Putnam, 1967; Davidson, 1980). There are some reductive physicalists who still insist that mental state could be explained by scientific accounts of physiological processes and states (Churchland, 1986; Churchland, 1981; Smart, 1956). This insistence is evidence to show that lack of understanding of the dichotomy between form and abstract. Science can measure form or the physical world; however, it cannot measure abstract. Nevertheless, scientific research in neuroscience continues to prove precisely that which, by its nature, is not capable of being proven directly through instruments (Farah *et al.*, 2009; Koch, 2009). Some writers already admit that the western understanding of the mind is incomplete (Denett, 1998; Searle, 2001).

In this paper, we assert that the mind is a stream of consciousness composed of discrete moment-to-moment connection (Karunamuni and Weerasekera 2017; Karunamuni, 2015). This discrete moment is created by the state of awareness of cognition where consciousness is created in one of the four building blocks: form (*ruppa*), emotion (*vedhana*), memory (*sanya*), and synthesis (*sangkhaRA*). If the Mind is "M" and other building blocks are designated as F, E, M and S respectively. The stream of consciousness consists of all possible combinations in all possible order of (MF; ME, MM and MS) discretely, meaning distinct pair, and independently, meaning no one pair depends on the other and no two pairs may occur simultaneously. As each pair clings or bonds occur, a spark of consciousness is created. With this creation, awareness is made. This awareness can never precede the occurrence, but only after bonding, remaining, and extinction of the pair. The awareness is made when the new bonded pair is made. This recognition occurs at (M*+1), and never at M* because the occurrence of the pairing is too fast and the remaining of the binding is too short. The bonding, remaining, and extinguishing of the pairing of this stream of consciousness defines the mind. The mind, in essence, is the stream of consciousness. What is consciousness? We answer this question in section 1.3, *infra*.

1.2 The four building blocks as a foundation of the mind

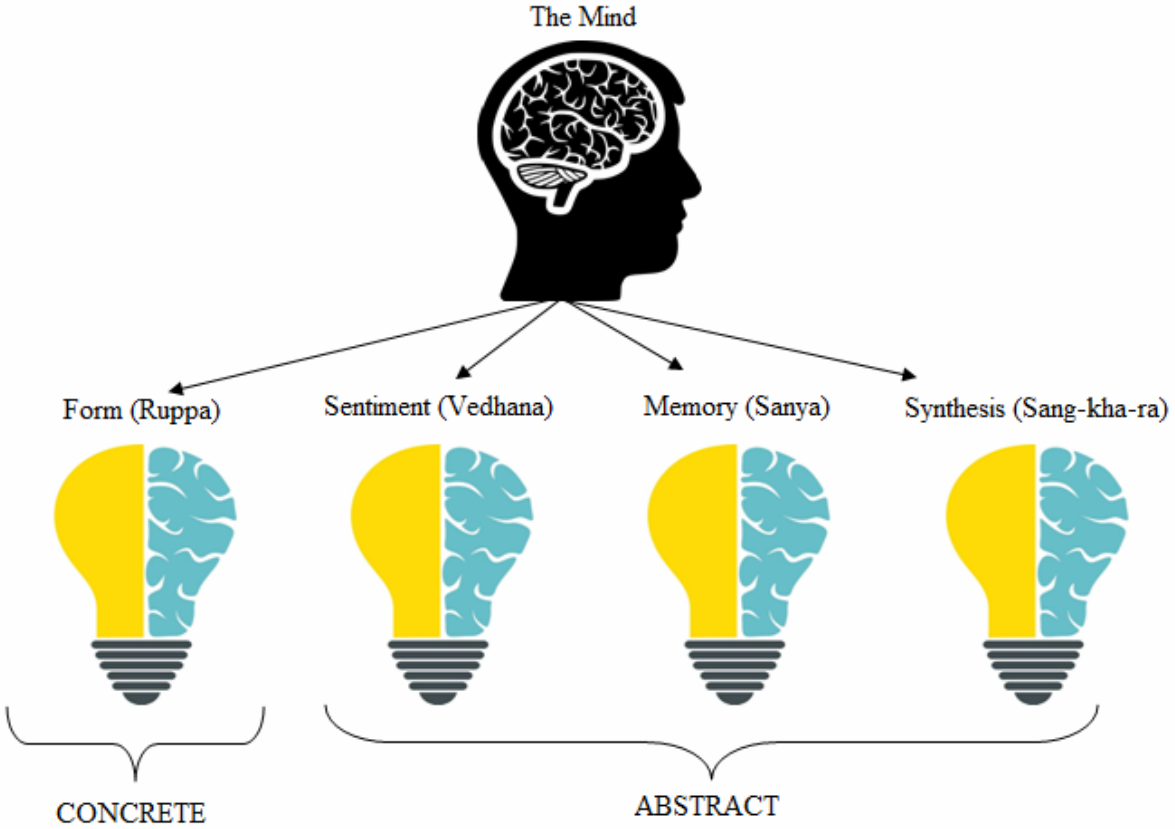
Consciousness is the state of awareness and knowing. Awareness means knowing of the external stimuli and knowing means ability to receive, process, and evaluate the stimuli through the six receptors. These six receptors are: ears for hearing, eyes for seeing, tongue for tasting, body for touch, and cognition.

The mind possesses certain characteristics that we can observe. *Firstly*, the mind is neither enduring nor permanent; it arises and is extinguished. *Secondly*, the mind occurs within a boundary of its building blocks; these building blocks include (i) form or body, (ii) emotion, (iii) memory, and (iv) synthesis.

The form or body of which the mind clings is the physical or material form which could be touched and felt. The remaining three building blocks (emotion, memory, and synthesis) are abstract. Thus, the mind may also be looked upon as a state of consciousness that is comprised of form and abstract. *Thirdly*, the mind arises, remains in its building block and is extinguished in the same place where it arises. For instance, if the consciousness recognized a material object, it is said that the mind arises at the form building block. Within a fleeting moment, for the mind cannot remain in one state for so long, it would appear in one of the three building blocks. Let us call each appearance or arising as a *spark* is flickered off at the form, a new one appears in another building block, say, memory. At that point the mind recalls an event or series of events from the person's

past and inures itself with the emotion of that past event. That inurement of emotion is the function of the mind through the contemporaneous function of the mental faculties. This spark too will not last long, and sooner will it be extinguished. Upon its extinction, a new spark will appear in one of the four building blocks. This process repeats itself over and over throughout the state of a person's consciousness. This is called the working of the mind where the mind arises, remains, and extinguishes in the same place. This arising, remaining and extinction is a spark of thought. Each blink of the spark represents the on-and-off of the spark in one of the four building blocks. Thus, at any moment we can track the location of the mind as to where it stands. By the law of its nature, the mind cannot wander off to any locations other than these four places: (i) form or body, (ii) emotion, (iii) memory, and (iv) synthesis.

Fig 1. The four building blocks of the Mind



Note: The four locations called building block of the mind are (i) form or body, (ii) emotion, (iii) memory, and (iv) synthesis. The mind can be at one place at one time. We realize where the mind had been only after it had left that location.

1.3 Consciousness defines the state of mind

1.3.1 Consciousness in Western literature

Consciousness is defined as the state of awareness of the external object or in internal within oneself (van Gulick, 2004). One text in modern psychology defined consciousness as an "executive control system of the mind." (Farthing, 1992). Defining consciousness is not easy, but there is a common understanding among writers and philosophers of what is consciousness (Searle, 2005). Western understanding of consciousness is evident by the use of the term "awareness" to describe it. In modern time, writers from cognitive science, psychology, and anthropology continue trying to define consciousness (Trnka and Lorenciva, 2016). In modern medicine, attempts had been made to study consciousness through measuring various state and responses by the mind through alertness, comprehension, disorientation, delirium and movement in response to painful stimuli (Guzeldere,

1997). Some western attempts to study consciousness have practical applications when it is used to assess consciousness in comatose or anesthetized patients (Fins *et al.*, 2007).

John Locke defined consciousness as "the perception of what passes in a man's own mind." (Locke, 1690). Diderot and d'Alembert's *Encyclopédie* defined consciousness as "the opinion or internal feeling that we ourselves have from what we do." (Diderot and d'Alembert, 2014).

In the English language, the word "consciousness" is derived from the Latin *conscius* (con- "together" and scio "to know"). It has been interpreted to mean "knowing together or common knowledge" (Lewis, 1990). However, we will later point out that this interpretation is wrong, despite the original coining of the Lain was correct.

Thomas Hobbes wrote: "Where two, or more men, know of one and the same fact, they are said to be Conscious of it one to another." (Hobbes, 1904). This attempt to illustrate consciousness in Hobbes' *Leviathan* is also a failure because it illustrates consciousness as co-dependence of knowing the object by two persons. Consciousness does not depend on the existence of another person nor anyone in the world. The inner mind of the person alone defines consciousness. From the western literature the reference of consciousness to the "self" was best exemplified by the Archbishop Ussher who wrote in 1613 of "being so conscious unto myself of my great weakness." (Ussher, 1613).

From historical record, there are also some misunderstandings in attempts to link consciousness with the concept of "conscience." Consciousness is not the same as moral conscience. The Early Latin writing of Cicero, for instance, took a literal meaning of the original Latin: *Conscientia* which means to know together (Cassin, 2014). Thus, in its earlier application, it was said that *conscientia* connotes the witness has the knowledge of someone else's action (Molenaar, 1969). Descartes also made an attempt in applying *conscientia* in a different light. Descartes took *conscientia* to mean conscience, i.e. awareness of right and wrong (Hennig, 2007). In "Search after Truth" (*Regulæ ad directionem ingenii ut et inquisitio veritatis per lumen naturale*, Amsterdam 1701), Descartes wrote that "conscience or internal testimony" (*conscientiâ, vel interno testimonio*) defines *conscientia* (Adam and Tannery, 1908; Heinämaa *et al.*, 2007). Conscience is knowing the difference between right and wrong. However, this knowledge is not consciousness. Consciousness is "knowing" in a continuous fashion or in an appearance of continuity as the mind leaves one building block and clings to another. From historical records of the western literature, we found attempts to define consciousness were unsatisfactory. We now turn to the dictionary definition of consciousness.

The Cambridge Dictionary defines consciousness as "the state of understanding and realizing something." A similar attempt at the definition was made by the Oxford dictionary which defines consciousness as:

> "The state of being aware of and responsive to one's surroundings."
> "A person's awareness or perception of something." and
> "The fact of awareness by the mind of itself and the world."

The Routledge Encyclopedia of Philosophy defines consciousness as:

> "**Consciousness**—Philosophers have used the term 'consciousness' for four main opics: knowledge in general, intentionality, introspection (and the knowledge it specifically generates) and phenomenal experience... Something within one's mind is 'introspectively conscious' just in case one introspects it (or is poised to do so). Introspection is often thought to deliver one's primary knowledge of one's mental life. An experience or other mental entity is 'phenomenally conscious' just in case there is 'something it is like' for one to have it. The clearest examples are: perceptual experience, such as tastings and seeings; bodily-sensational experiences, such as those of pains, tickles and itches; imaginative experiences, such as those of one's own actions

> or perceptions; and streams of thought, as in the experience of thinking 'in words' or 'in images'. Introspection and phenomenality seem independent, or dissociable, although this is controversial." (Craig, 1998).

According to Macmillan Dictionary of Psychology:

> "**Consciousness**—The having of perceptions, thoughts, and feelings; awareness. The term is impossible to define except in terms that are unintelligible without a grasp of what consciousness means. Many fall into the trap of equating consciousness with self-consciousness—to be conscious it is only necessary to be aware of the external world. Consciousness is a fascinating but elusive phenomenon: it is impossible to specify what it is, what it does, or why it has evolved. Nothing worth reading has been written on it." (Sutherland, 1989).

In Western literature, there is no coherent definition of consciousness (Sytsma and Machery, 2010). In some cases, this attempted definition breaks down to equate consciousness to nothing more than an intuition (Antony, 2001). Consciousness is abstract, not a material object (Ryle, 1949). Attempts to define it had been circular and unsatisfactory (Sutherland, 1989). In this paper, we define the mind and consciousness according to Buddha's teaching. The understanding of the function of the mind and the concept of consciousness were explained in the fifth century B.C. by Bhudda Gautama.

1.3.2 Consciousness in Buddhist literature

Consciousness is defined as the state of the mind to maintain the ability to recognize mental contact via six receptors and to process the stimuli according to the 14 steps of the mental process in the mind in order to give meaning to each stimulus. As a state of consciousness, the mind is the state of both awakening and awareness. As a state of awakening, the mind is conscious and, thus, can process data from external sources through the six receptors. These stimuli will be turned into information through the working of the mind. The mind works in 14 functions: (i) arising, (ii) maintain the existence of that arising, (iii) leaning toward one of the six senses according to the type of stimulus received, (iv) acknowledge the hearing of the sound and decide whether it is good or bad, (v) acknowledge the sight of the form and decide whether it is good or bad, (vi) acknowledge the smelling of the scent and decide whether it is good or bad, (vii) acknowledge the taste by the tongue and decide whether it is good or bad, (viii) acknowledge the touch of the sensation and decide whether it is good or bad, (ix) receive the emotion from the selected emotion from the five senses, (x) evaluate the emotion, (xi) make decision for the selection of the appropriate emotion for the stimulus, (xii) inurement of the selected emotion, (xiv) receive the emotion from the last step [xiii], and (vix) move from the moment by means of extinction of the spark.[1] From step (i) to (xiv), it is called one moment of the mind; the duration of which is less than a millisecond. Since it is not

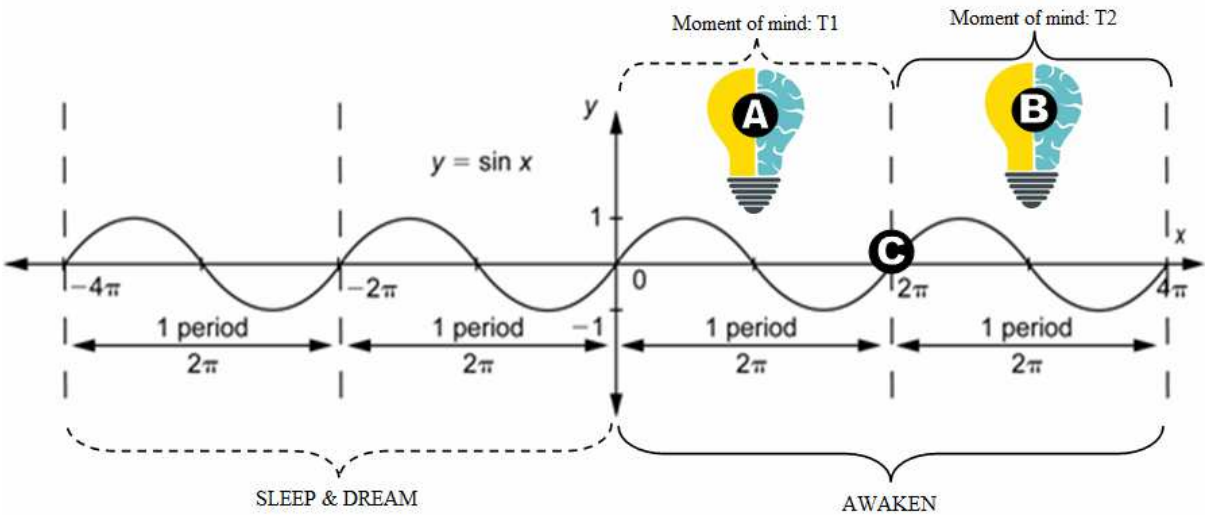
[1] 1. ปฏิสนธิกิจ ทำหน้าที่เกิด; 2. ภวังคกิจ รักษาดำรงภพชาติ; 3. อาวัชชนกิจ กิจที่รำพึงถึงอารมณ์ทั้ง 6; 4. ทัสสนกิจ ทำกิจเห็น เป็นกุศลวิบากหรืออกุศลวิบาก; 5. สวนกิจ ทำกิจได้ยิน เป็นกุศลวิบากหรืออกุศลวิบาก; 6. ฆายนกิจ ทำกิจได้กลิ่น เป็นกุศลวิบากหรืออกุศลวิบาก; 7. สายนกิจ ทำกิจลิ้มรส เป็นกุศลวิบากหรืออกุศลวิบาก; 8. ผุสสนกิจ ทำกิจกระทบสัมผัส เป็นกุศลวิบากหรืออกุศลวิบาก; 9. สัมปฏิจฉันนกิจ ทำกิจรับอารมณ์ต่อจากปัญจวิญญาณ; 10. สันตีรณกิจ ทำกิจพิจารณาอารมณ์ต่อจากสัมปฏิจฉันนะ; 11. โวฏฐัพพนกิจ ทำกิจตัดสินอารมณ์; 12. ชวนกิจ ทำกิจเสพอารมณ์; 13. ตทาลัมพนกิจ รับอารมณ์ต่อจากชวนะ; & 14. จุติกิจ เคลื่อนจากภพคือมรณะ.

capable of measurement by any instrument due to its speed and lack of physical form, the working of the mind, as also true for the mind itself, is abstract.

What we have described thus far is the working of the mind in a state of awakening. Does the mind continue to work during the state of unconsciousness or non-awaken state, such as during sleep? The existence of the mind depends on the living being or the state of being alive; it is only with the extinguishment of life or upon death would the mind cease to exist. During the non-awaken state, for example during sleep, the mind still functions and the evidence of the working of the mind is seen through dream. Dream is an experience of witnessing the occurrence of events or series of events in the mind during sleep capable of being made to be understood by the subject; dream is an evidence of the working of the mind during a state of non-awakening. As long as the person is alive, the mind continues to exist. In each moment of its existence, the mind continues to perform its functions in a 14-steps process. Each cycle of the 14-steps constitutes a moment of the mind or a single event understood by the mind.

The *moment* of the mind is defined as the episode that a person experienced by the working of the mind from step (i) to (xiv). The duration of this moment from its arising at (i) and ending in (xiv) is fleeting as a flicker of the spark of the thought itself; we may illustrate this rising and extinguishing by sinoid curve. Buddha analogized this duration to the length of time it takes to blink the eyes. In that millisecond the mind has accomplished one task in one building block and starts the spark at another building block. This flicking of the spark happens so fast that, the on and off of each sparks together would appear to be a continuous stream of light; thus, we observe that the state of consciousness is a "continuity" of a state of awareness. However, in reality the mind sparks are more discrete than continuous. The continuity is only an appearance due to the lack of the power of observation we possess. We see the mind's function only *after* the task has been accomplished, and never during its active engagement. The space between one flickering of a particular building block and the next is so infinitesimally small that it me be equated to a limit of zero. This limit was illustrated by an analogy where the Buddha attempted to define the space between the ending of one and rising of another building block as the ratio of a piece of dirt caught in the finger nail divided by the mass of the earth; hence, modernly, we may equate this illustration as the limit of zero. As a near zero value, the gap of one ending and another rising of the clinging of the mind, projects an appearance of continuity. Since the ability of our observation is lacking to see the disconnectedness of each spark, the moment in mind becomes a continuous form which we call time continuity. Here, we see the true definition of consciousness where the awareness, rising from observing of an event in the mind after its diminishing and rising of another, appearing to be a continuity of awareness; thus, *consentia*.

Fig. 2: Illustrating the moment of the Mind by wave length and frequency



Note: (A) represents the first thought, (B) represents the second thought, and (C) represents the gap of connecting point between (A) and (B); this space is infinitesimally small that it escape a common observation; thus, the transition from (A) to (B) becomes so fast that it gives an appearance of a continuity.

1.4 Types and levels of consciousness

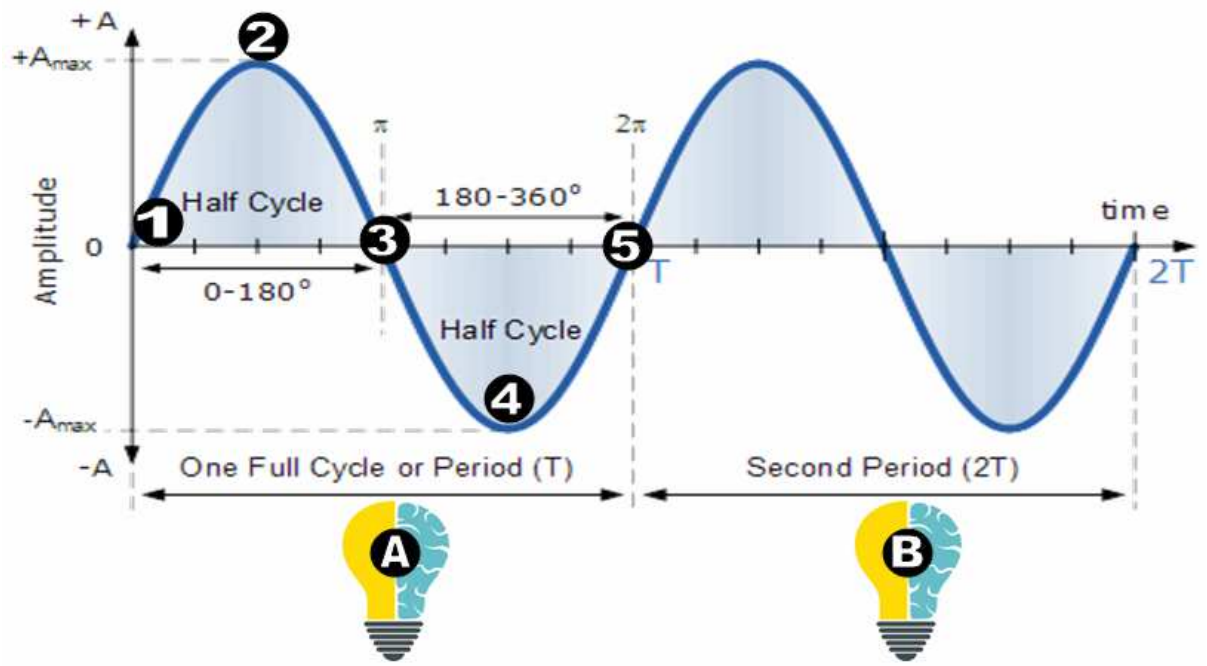
From the Buddha's perspective, consciousness is the cognition of the mind's event observable from a current locus after the diminishing of an event in a prior locus. The mind cannot know simultaneously of an occurrence of an event; it knows only after the event is observed, registered, and a proper interpretation is made according to the 14 steps of the working of the mind. The mind is able to recognize two types of event or stimulus: form and abstract. Under this framework, consciousness is divided into two types: (i) *ruppa-yanna* or form dependent consciousness, and (ii) *aruppa-yanna* or consciousness that does not depend on form, i.e. it depends on abstract.

The *form dependent consciousness* is classified into 4 levels, namely primary (*pathom-yanna* or primary state of consciousness), secondary (*tuti-yanna* or secondary state of consciousness), tertiary (*tati-yanna* or tertiary state of consciousness) and quartro (*jatu-yanna* or fourth state of consciousness).

There are four types of consciousness that does not depend on form. These abstract consciousness include awareness of (i) space is boundless (*akasananja-ayatana yanna*), (ii) consciousness is infinite (*vinya-nanja-ayatana yanna*), (iii) state of nothingness (*akin-janya-ayatana yanna*), and (iv) a state of neither perception nor non-perception or neutralism (*neva-sanya-nasanya-ayatana yanna*).[2]

Fig. 3: Form dependent consciousness

[2] อรูปฌาน 4 ฌานมีอรูปธรรมเป็นอารมณ์ ฌานที่เป็นอรูปาวจร ได้แก่:1. อากาสานัญจายตนะ (space is boundless); 2. วิญญาณัญจายตนะ (conscious of consciousness is infinite); 3. อากิญจัญญายตนะ (conscious of the sphere of nothingness); 4. เนวสัญญานาสัญญายตนะ (อัปปนาสมาธิ) (state of neither perception nor non-perception)
See:
http://84000.org/tipitaka/dic/d_seek.php?text=%CD%D2%A1%D4%AD%A8%D1%AD%AD%D2%C2%B5%B9&detail=on



Note: The *primary consciousness* is composed of (1) awareness (*vitaka*), (2) pondering (*vijara*), (3) joy (*piti*), (4) happiness (*sukkha*), and (5) unity of mind (*Ekaggata*).

1.4.1 Form dependent consciousness has four levels

The *primary consciousness* is composed of awareness (*vitaka*), pondering (*vijara*), joy (*piti*), happiness (*sukkha*), and unity of mind (*Ekaggata*) (Fig. 3). The first contact the mind makes with the outside world is by receiving the stimulus through one of its six receptor organs: ears, eyes, nose, tongue, body, and cognition. The mind processes each type of contact one-by-one and gives its meaning. At this first stage of consciousness, the mind uses all five levels to process the incoming stimulus (data) in order to give information (understanding). This level of consciousness is present in all living persons in a waking state. Since it requires no skill or training but allowing the mind to process the stimulus after the initial contact, it is classified as a primary or basic form of consciousness.

The secondary level of consciousness is composed of joy (*piti*), happiness (*sukkha*), and unity of mind (*Ekaggata*). This second level of consciousness is considered a more developed because the ability for the mind to know or attain cognition does not depend of awareness and pondering. By mental contact with the object, the mind immediately recognizes the object and could maintain the state of consciousness, ready to know, requires only three elements to sustain consciousness: joy (*piti*), happiness (*sukkha*), and unity of mind (*Ekaggata*). The removal of the first two elements (awareness and pondering) had been removed as unnecessary in order to reach joy, happiness and unity of mind. In order to use only joy and happiness to achieve unity of mind, the mind must be trained to remove the first two procedures for the mind's data processing. When the mind can process stimulus and reach cognition without the need of awareness and pondering the object or stimulus, it is said that the mind is skillful at some level. This level is a second level of consciousness.

The third level of consciousness requires only two components: happiness (*sukkha*), and unity of mind (*Ekaggata*). At this state of consciousness, the mind knows only joy and mental unity; it requires only joy and mental unity to given meaning the object upon the mental contact with form or material. Unity of the mind is reached with only one requisite: happiness. A state of happiness (*sukkah*), once reached, may allow the mind to attain a state of unity. A person who is happy may be said to be in a state of bliss; the mind of such a person is stable or unshaken. This stability of the mind is called unity or singularity.

The fourth level of consciousness is composed of equanimity or peace of mind (*ubek-kha*) and mental unity or the mind having a singularity in emotion. This fourth level of consciousness is the highest level of consciousness that depends on tangible form or material to exist. The tangibility that gives meaning to the mind through the six receptors may be recognized at the first level where consciousness consists of five components. As the mind is developed, these components are dropped until one (mental unity) is left and a new one (*ubek-kha*) is added. Reaching the fourth level of consciousness requires training. This training comes in a form of meditation.

1.4.2 Form independent or abstract consciousness has four levels

If the mind is further trained, after the fourth level of form dependent consciousness, the mind enters into formless consciousness or consciousness that does not depend on form in order to reach unity. The first formless type of consciousness is called *akasa-nanja-ayatana*[3] or using the air or open space as the basis for cognition. For example, in an awaken state, a person can stare into open space and give meaning to an object or thinking while staring at open space. The second formless type of consciousness is called *vinya-nanja-ayatana*[4] or the recognition that consciousness is infinite. The third level of formless consciousness is *akinja-ayatana*[5] or the recognition of a state of nothingness. Lastly, the fourth level of formless consciousness is called *neva-sanya-na-sanya-ayatana*[6] or the mind recognizes a state of neither perceive nor non-perceive of the outside world. The mind has been trained to sever all six senses receptors from receiving external stimulus in order to experience the 4 types of abstract consciousness.

Note that the form independent, formless or abstract consciousness is not the same as subconsciousness. Subconsciousness or consciousness in a non-waking state still depends on form stimulus through the six receptors to make meaningful interpretation of the mental contact of the stimulus. For instance, dream during sleep is a form dependent consciousness that is synthesis through *ruppa* (form), *sanya* (memory), *vedhana* (emotion) and *sangkhara* (synthesis), such as the working of the mind during its waking state at the primary level of consciousness. The waking and non-waking state of the mind does not change the manner in which the mind works in the context of consciousness. Consciousness depends on life; so long as the being is alive, consciousness is present. Therefore, during sleep, consciousness is still present. Since sleeping is not death, the mind continues to work according to its nature. What is the nature of the mind? The consciousness, both during the waking and non-waking states, arises and extinguishes like a spark of light that goes on and off in one of four building blocks and then on-and-off again in another building block. This process keeps repeating infinitely throughout the life of the person. The iteration of the mind rising and extinguish in one of the building block in one's life defines an observable infinity. Infinity may be defined and observed in this way.

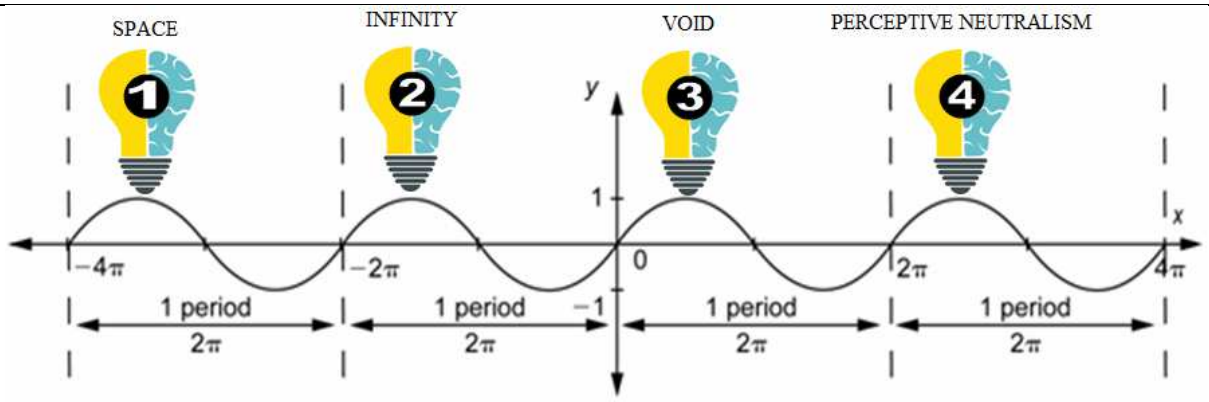
Fig. 4. Abstract consciousness or consciousness not dependent on form

[3] อากาสานัญจายตนะ (ฌานอันกำหนดอากาศคือช่องว่างหาที่สุดมิได้เป็นอารมณ์ หรือภพของผู้เข้าถึงฌานนี้ - sphere of infinity of space).

[4] วิญญาณัญจายตนะ (ฌานอันกำหนดวิญญาณหาที่สุดมิได้เป็นอารมณ์ หรือภพของผู้เข้าถึงฌานนี้ - sphere of infinity of consciousness)

[5] อากิญจัญญายตนะ (ฌานอันกำหนดภาวะที่ไม่มีอะไรๆ เป็นอารมณ์ หรือภพของผู้เข้าถึงฌานนี้ - sphere of nothingness)

[6] เนวสัญญานาสัญญายตนะ (อัปปนาสมาธิ) (ฌานอันเข้าถึงภาวะมีสัญญาก็ไม่ใช่ ไม่มีสัญญาก็ไม่ใช่ หรือภพของผู้เข้าถึงฌานนี้ - sphere of neither perception nor non-perception)



1.2 Mental faculties

Mental faculty (*cetasika*) refers to the nature of mental faculties that arises with the working of the mind; it is *that* which occurs in the mind. Mental faculties are emotions which are equivalent to mental faculties that serve as the components of the mind; it is classified as the capacity and the property of the mind. It occurs simultaneously with the function of the mind being an evidence of the emotion of the mind. Mental faculties are categorized into 3 cantos. First, emotional mental faculty refers to the instability of abstract components of the mind. Second, memory mental faculty refers to the ability to recall past events. Third, the remaining 50 components of mental faculties are categorized as synthesis mental faculty which includes all abstract components and the function of the mind.

Mental faculties refer to the type of nature that serves as a group of components for the make-up of the mind; it allows the synthesis of mental experiences, such as feelings, emotions, judgment, etc. Components of mental faculties which comprise the mind have four characteristics: (i) occur at the same time as the mind, (ii) distinguish at the same time as the mind; (iii) having the same sentiment as the mind; and (iv) depends on the same condition as the mind.

The mind and mental faculties depend on one another. Suppose that the mind is water and mental faculty is a red dye, by combining the water and the red dye, a reddish solution is produced. As the water and the red dye could not be separated after they had been mixed, like so that the mind and mental faculty could not be separated from one another. The four characteristics of mental faculty are (i) mental faculty depends on the mind to exist, (ii) the function of mental faculty is to coexist with the mind, (iii) the output of mental faculty is the sentiment of the mind; and (iv) the cause for the arising or occurrence of mental faculty is the occurrence or function of the mind.

The synthesis of mental faculties that occurs at the same time with the mind allows the mind to have different feelings, sentiment or emotion, such as knowing the effect of pleasure, of consciousness of form or abstract, or even the diminishment of all function of the mind by means of reaching *nirvana*, i.e. a state of absolute emptiness.

The mental faculties or *cetasika* consists of 52 components which may be divided into three main types, namely (i) anyasamana cetasika which may be used to comprise the working of the mind; it is known as the middle-ground type of mental faculty. Anyasamana cetasika is further divided into two categories *suppachitasatarana* with 7 kinds and *pakinaka cetasika* with 6 elements; (ii) *akusala cetasika* (impurity) consisting of 14 elements which include *lobha* (greed of 3 kinds), *dhosa* (anger of 4 kinds), *moha* (ignorance of 4 kinds), dhituka (defeatism 2 kinds), and *vijikija* (doubts 2 kinds); and (iii) *sobhana cetasika* (purity). There are 4 categories of pure mental faculties; these include *sadharana* (general 13 kinds), *viratti* (righteousness 3 kinds), *appamanya* (infiniteness 2 kinds), and *panya* (knowing or intelligence or wisdom 1 kind).

Table 2. Components of 52 types of mental faculties

Neutral Effect		Unhealthy Effect		Healthy Effect	
Universa	Occasiona	Universa	Occasional	Universa	Occasional

l	l	l				l			
-	-	-	Greed	Hate	Other	-	Abstinence	Infinity	Wisdom
1* 2 3 4 5 6 7	8 9 10 11 12 13	14 15 16 17	18 19 20	21 22 23 24	25 26 27	28 29 30 31 32 34 35, 36 37, 38 30, 40 41, 42 43, 44 45, 46	47 48 49	50 51	52

*See Appendix 1 for the names of all elements of emotions or mental faculties.

2.0 ANYASAMANA CETASIKA: THE MIDDLE PATH OF MENTAL FACULTIES

Anyasamana cetasika refers to the middle path of the mental faculties. The term itself allows us to infer that the mental faculties may be seen as having composed of two extremities, namely purity and impurity; in the middle lies *anyasamana cetasika* or the middle mental faculties having neother good nor bad effect. The middle mental faculties may be combined with the working of the mind which consists of the good, bad, and neutral. There are 13 elements of the middle mental faculties which further is divided into two subgroups. These two subgroups are (i) *suppachitasatarana* with 7 kinds and (ii) *pakinaka cetasika* with 6 kinds.

Table 3. The middle path of mental faculties

Middle Path Mental Faculties with Neutral Effect on the Health of the Mind	
Universal or General Occurrence	Occasional or Specific Occurrence
1. Contact 2. Feeling 3. Perception 4. Intention 5. Unity of mind 6. Life faculty 7. Attention	8. Initial thought 9. Sustained thought 10. Determination 11. Energy 12. Rapture 13. Wish

2.1 *Suppachitasatarana* or the general mental faculties (*mentis publicus*)

Suppachitasatarana cetasika refers to the general mental faculties that could be experienced by all members of the public. This serves as a component for the general functioning of the mind. When this group of mental faculties becomes part of the mind, all 7 elements of these known public mental faculties enter the mind simultaneously. These 7 elements cannot be separated; thus, it is called public mental faculties. If each element or some elements could be separated from the group, then each person may select to experience one or some elements of this type of mental faculties; thus, the group of 7 faculties would cease to be public. However, since these 7 elements cannot be separated from one another nor can each one of these 7 components work independently of one another, they are called public or generalized mental faculties. These 7 components include: (i) *Ekaggata* (unity), (ii) *sivita-insariya* (vitality), (iii) *manasikara* (mental), (iv) *vedhana* (feelings), (v) *sanya* (memory), (vi) *chetana* (intent), and (vii) *bhassa* (contact).

Ekaggata refers to the "unity of the mind." The mind or thinking process works in a step-by-step process. The external stimuli enter through the 6 senses: hearing, sight, taste, smell, touch, or mental component or *cognition*. In the western culture, only five senses are recognized; however, in the Buddhist teaching, there is the sixth dimension called cognita or the mental decider or *chitta* or *chaiya*. As the person receives the stimuli, the mind searches for the correct type of emotion or interpretation through assigning meaning called a type of emotion. Once the correction interpretation and meaning is assigned, the mind reaches a state of satisfaction or bliss. That moment of bliss which the mind successfully solved a query, is called *Ekaggata* or mental unity, a single moment of recognition that the problem (stimulus) received from the external environment, received through one of the six receptors, had successfully been interpreted and assignment of meaning, called understanding had been completed. This state of the mind having understood the message is called a unity or *mentis concordia*. By its nature and function, the mind is a problem solver. Each stimulus received by the mind is seen as a query that needs to be solved by giving proper meaning to the stimulus. This, the stimulus received is seen as raw data; the processing of the mind by giving meaning or interpretation turns the data into information. This, the person is informed, i.e. know. Once a meaning is assigned, the mind reaches a state of *Concordia*. Whether the assigned meaning is correct or not is a subjective judgment made by the mind. Sometimes, the assignment meaning or the interpretation is incorrect when compared to objective standard, i.e. giving wrong answer to an exam question nevertheless the mind had accomplished its task. *Mentis Concordia* is not about correct or incorrect interpretation, but as a completion of the task by the mind. If the mind is presented with a query and is unable to reach *mentis concordia*, it will repeat the attempt to find the answer. If after repeated attempts it could not find the answer and still continues attempting, stress or mental strain starts to appear. This is one way that stress or mental strain is formed.

This ability to attain *mentis concordia* is universal ability. All human are capable of attaining such mental state. It is a prime condition for mental functioning or thinking process. For the western basis of the five senses of receiving stimuli from the external environment, attaining the state of *mentis concordia* is almost self-explanatory because it is rudimentary. However, for the eastern concept of the sixth receptor claiming that the *mind* itself is another receptor capable of receiving, sensing, interpreting, and achieving state of *mentis concordia* may seem redundant because the experience of *mentis concordia* itself is a state of mind. This argument is not a minor point and needs to be explained.

We may use the word "mind" in two different contexts. Let us spell the word "Mind" with capital "M" to refer to the general working or function of the mental engine that encompasses of experience in receiving, interpreting and reaching the state of *mentis concordia*. Let us use the work "mind" with small "m" to refer to the mental state of consciousness to receive sensual stimuli from the external environment (mental contact). This *mind* serves as if it is an organ of senses, but a true organ is organic; the *mind organ* is inorganic and it is dependent upon the existence of the living being. It is a state of consciousness combined with the ability to process the stimulus data and turn into information. Like the ears that process sound, eyes that process form, nose that smells, tongue that tastes, body that feels touch, the *mind* is a state of consciousness that processes data from the external environment in both form and abstract by means of mental contact. When the physical organ of senses depends on the function of the physical life of the living being, the *mind inorganic* depends on the vitality of that living physical form. It depend on the form to exists, just as the mental faculties depends on the Mind to exist, the *mind inorganic* depends on the living body with the five organ senses to exist. The life of a living being has aspects of what we call living. On the one hand, the physical being comprising of the five organ senses, we may called this physical form of living as *vita corporeus*. On the other hand, the mind receptor or the sixth component of receptor is non-organic and could be called *vita perceptus* or mental contact.

With this explanation of the *mind inorganic* as a sixth receptor to achieve *mentis concordia*, we are forced to make a bold assertion that "life" consists of both physical and non-physical. The

physical life or *consciousness* is easily understood through its physical form equipped with its five organs of senses: ear, eyes, nose, tongue, and body. The non-physical is the sixth dimension of senses which we described above as the *mind inorganic* which is capable of processing external stimuli and reaching a state of *mentis concordia*. These two aspects of life's consciousness might allow us to assert that *consciousness* of a living being consists of *form* and *abstract*. The "form" is one which may be found through the five physical senses. The "abstract" is one which may be found in the *mind inorganic*. Both form and abstract function together to process external stimuli and help the Mind to reach a state of *mentis concordia*.

Sivita-insariya is the "vitality" of a living being or faculties of a living organism or human being in an abstract form or non-material. Vitality may include the Mind, mental faculties, age, being alive, continuity during the life span of a living being, the characteristic of being a living person, all that which we called living or being alive. Vitality is abstract because its existence depends on the living being to manifest its properties and characteristics. As a sign of life, it depends on the living. A dead animal represents non-living; it is nothing more than a corpse of a once living being. A living animal, on the other hand, manifests signs of its state of being, i.e. the thinking, movement and experience its environment, both internal and external. This sign of life, which we called vitality, is public. Everyone may experience it as part of being alive. There is no need for special training to experience living or of being alive. Signs of being alive is not a privilege, but may be experienced by all living beings.

Manasikara or "mental effort" is the third kind of public mental faculties (*mentis publicu*s). Mental effort is the ability to think or the use of one's ability to think. This ability is classified as public because everyone possesses this ability. It is considered one of the 7 pillars in *mentis publicus* because everyone is capable of thinking and engaging in a thinking process or mental process without special training. For a human being, this ability comes as a natural ability. When a person thinks about something, a mental effort is manifested.

Vedhana or "emotion" is the fourth kind of public or general mental faculties. All members of the public is capable of experiencing and expressing emotion. There are three types of emotion, namely (i) like, (ii) dislike, and (iii) neutral. These three types of emotions may be generated by time components where the past, presence, and future stimuli may evoke one or two or three types of emotion in a person. The memory of pain, for instance, is the working of time component of the past with the non-pleasure or dislike emotion of the presence that a person feels. The positive feeling of looking forward to some rewarding or honorific event in the future is a result of combining the positive emotion or "like" with the time component (future). This ability of the Mind is classified as general or public (*mentis publicus*) because everyone may experience it without special training. It is a natural ability of all human beings.

Sanya or "memory" is the fifth kind of public mental faculties. Everyone possesses memory and can recall that memory of recorded past events without any difficulty. This type of mental faculties or ability is classified as *mentis publicus* or public or general knowledge of the mental faculties because it is natural and does not require special ability to experience it.

Chetana or "volition or intention" is the sixth kind of public mental faculties. All conduct or action starts with volition or intention. Intention is the willing of the mind to undertake a certain action where a specific outcome had been the aim of such mental volition. So long as the Mind functions, it may form intention. An act in accordance with the intent is a volitional act. A volitional act is an act that is dictated by the will of the person. So long as the person can form a will, the person is capable of exerting intent. Since intent is a characteristic of the Mind which may be formed and expressed without special ability or training, as all members of the public may do so; it is, thus, classified as *mentis publicus* or a general and public class of mental faculties.

Bhassa or "contact" is the seventh kind of public mental faculties. It is considered part of a general mental ability of the general public because it could be experienced by everyone without special training. The contact refers to the receiving of outside stimulus through the five physical senses (life form) and the sixth sense by the mind (life abstract or *vita perceptus*). There are two

types of contact, physical contact and mental contact. The physical contact is the contact that may be recognized by the six sensing receptors. The sound makes contact with the ears in a form of hearing. The form makes contact with the eyes through sight. The scent makes contact with the nose by smelling. The taste makes contact with the tongue by tasting. The touch makes contact with the body by physical touch. These five types of contact are together called physical contact. Lastly, the sixth type of contact is the mental contact by means of cognition. The seventh kind of public mental faculties (*bhassa*) is the mental contact. This mental contact, recognized by cognition, may be experienced by everyone without special skills or training; thus, it is classified as *mentis publicus* or mental state of the general public.

In summation, the public or generalized mental faculties (*Suppachitasatarana cetasika*) are defined as the mental abilities that may be experienced by all members of the public; thus is known as general mental faculties. In order to experience these mental faculties, there is no need for special training. This public mental faculties or *mentis publicus* forms the basis of human understanding among members of human species. One can assume that all members of the human species possess these seven kinds of mental abilities and, as the basis of their mental faculties and the functioning of the human mind, they provide members of human society the easy of effective communication. They serve as common bases to allow us to experience "group thinking" since all members possess the same abilities, as a common source of the mental code for communication, this *mentis publicus* is considered an achievement for the human species.

2.2 *Pakinaka* or specific mental faculties (*mentis certus*)

A second class of mental faculties called *pakinnaka* or specific mental faculties (*mentis certus*); its occurrence does not concur with the arising of the output of the Mind every time. For instance, when the mind thinks of a certain thought, it is necessary that such a thought is accompanied by a specific type of emotion: like, dislike, and neutral. There are six kinds of *mentis certus*. They may enter the Mind and formulate the expression of the mind, but they do not all enter at the same time. These six kinds of *mentis certus* enter the mind individually and separately at different moments. These six kinds of non-public or *mentis certus* include: (i) *vitaka* (awareness), (ii) *vijara* (consideration), (iii) *adhimaka* (following or convincing), (iv) *chandha* (willingness or satisfaction), (v) *viriya* (efforts), and (vi) *piti* (joy).

The first kind of specific or *mentis certus* is called *vitaka* or awareness. Awareness is defined as the mental focus of something. The condition under which awareness exists is one characterized by the awakening of the mental state, i.e. awaken means conscious, and there is an object on which the mental state focuses its attention upon the target object. Consciousness is a condition under which the Mind receives, processes, and reaches cognition. This focus is called awareness. There are two requisites for this state of mental faculties: (i) awakening of the mind or the mind is not asleep, and (ii) a mental focus on a particular object or focal point. This does not happen automatically. A certain object may exist and the mental state may be awakened; however, unless there is a focus or the volitional willing of the mind to force the mind to focus on the object, that awareness does not occur. For this reason, this mental ability or faculties is non-public; it happens only in the person who satisfies both conditions: awaken and wielding the mind to an object of focus. By whatever cause or reason, this ability may not exist in everyone as a matter of fact; it is an outcome of a volitional act. Its occurrence is not general, but occasional. Not all persons experience it at any given moment, only a particular person can experience it upon a stimulus; thus, it is called occasional.

The second kind of *mentis certus* is called *vijara* or consideration or pondering. The precondition for mental consideration is awareness. In order to consider or ponder something, that *something* or object must first become a focal point of the attention of the observer, i.e. the observer must have the awareness of the object. Since awareness of the precondition for consideration, and that awareness is specific or *mentis certus*, then consideration or pondering too, by default is *mentis certus.* It is a mental ability which does not occur automatically, but requires a mental effort as a

precondition. This exertion of mental effort may require training or volition on the part of the observer. Therefore, consideration or ponder is not a general mental ability.

The third kind of *mentis certus* is called *adhimaka* which means following or convincing. In order for the Mind to become convinced of any data or stimulus present to it, the mind must be aware of the stimulus, ponder upon the stimulus and enters a third phase of mental efforts in coming to a conclusion of being convinced or found interest in the stimulus. When a person pays attention to a stimulus, say a lecture in a study hall, the Mind works in the same manner. First, the person is aware of the lecture being presented. The person makes the mental note of the object and ponders upon the information presented. Before coming to any conclusion or become convinced by the speaker or of the subject matter, the student must attentively follow the subject matter. This third kind of *mentis certus* requires even more mental efforts than the prior two (awareness and consideration), this premeditation by wielding the mind to follow the presentation or stimulus allows the observer to engage in a mental exercise. This mental exercise is a mental work engaged through a volitional and voluntary act of the observers; therefore, this type of mental faculties does not exist in all persons for any given stimulus. It happens only in a person who has the awareness of the object, ponders upon that object, and follows through it.

The fourth kind of non-generalized or specific mental faculties is called *chandha* or willingness or satisfaction. It is classified as *mentis certus* or specific and non-general mental state because it requires active engagement by the observer or subject in the object. The person would have to go through all prior three kinds of mental elements: awareness, consideration, and following, in order to come to willingness or satisfaction. If we look at this fourth kind of mental faculties in a stage-by-stage format of the working of the Mind, we see that the three prior mental faculties laid the foundation for this fourth one. The mental willingness or the conclusion of satisfaction would not be possible without "awareness, consideration, and following" as prerequisites. Therefore, since all three prior mental faculties are classified as *mentis certus*, this fourth stage of mental work must by condition be likewise specific and occasional. We may return to the example of a student listening to the lecture. At the last stage, he had manifested awareness, pondering the content of the lecture, and following through the presentation, at this point the student makes a decision of whether he is satisfied with the presentation of the subject matter. This mental experience is specific to the student or the observer, not enjoyed nor engaged by the public, it is specific to one who is engaging in the activity. The activity is the presentation of the stimulus where the observe becomes aware of the stimulus, considers the stimulus attentively, follows through with the presence of the stimulus, and makes a conclusion about the stimulus. This activity or mental exercise is specific to a particular observer and does not happen simultaneously nor is it a happenstance. The activity in these four stages of mental exercise does not happen by chance; they are the outcome of a volitional act or series of mental acts.

The fifth kind of specific mental faculties or *mentis certus* is called *viriya* or efforts. Effort is defined as attempt and attempt is a volitional act. Such an act is an outcome of intent. An intent must first be formed. That formation then the intent is expressed through a volitional act, inwardly or outwardly, this volitional act culminates to a continuation of an action. This is how efforts are manifested. The mental effort that serves as part of non-general or *mentis certus* in the rubric of mental faculties sees the continuation of the working of the Mind.

Lastly, the sixth specific mental faculties is called *piti* or joy. As the mental efforts is being exerted in a continuity from the fifth *mentis certus*, assume that the stimulus is something positive or that it may be called "stimulating" as it had attracted an continuous efforts of the mind to follow it, the observer enters a stage of joy. This joy may come from an understanding of the subject matter presented from the external environment. For the student in our example, the joy may occur when the student understands the subject matter or can find meaningful application of the newly acquired knowledge. What if the student finds the subject matter not interesting or that it is not stimulating, the outcome of the mental faculties may be the opposite. Instead of joy, the student may find it not enjoyable. It does not matter what the mental outcome of the student may be, this fifth kind of non-

public mental faculties is one possibility; the person processing the stimulus does not have to "enjoy" the stimulus; joy is one possible outcome. There might be other mental outcome from the process.

We commonly attribute "joy" to a sentiment or feeling of happiness. Although such a common attribution is not entirely wrong, it is not a precise conclusion of what we experience in the Mind. Similar to *mentis concordia* (*Ekaggata* under *mentis publicus*) that we presented earlier, joy in the sense of mental faculties context is momentary, as if analogous to a spark of light that arises then sooner vanishes; the length of existence of joy may be as short as a blink of an eye. We need to rely upon the power of the Mind to recognize its arising and extinction. This is different from the common definition of happiness where people attribute the state of lasting joy, thus, the term "enjoyment" enters our vocabulary to express such a sentiment or feeling. That type of enduring sensation of enjoyment is more superficial and does not explain the working of the mind. The primal cause of that enduring sentiment commences with the spark of joy whose existence is more fleeting than enduring that gives rise to the recognition of its transient existence and the observer captures and replays it over and over again to extend its effect by relying on memory (*sanya*)---hence, a fleeting moment of joy turns into a lasting enjoyment. The rewind and replay happens in such a high speed that it appears to the untrained Mind as if it is continuity from moment-to-moment feeling or recognition of a feeling or emotion. This superficial observation gives an appearance of continuous state of joy; an experience commonly called happiness.

3.0 AKUSALA CETASIKA (*MENTIS MALUS*)

The discussion we presented thus far is confined to the public (*mentis publicus*) and non-public mental faculties (*mentis certus*) which consist of only positive or neutral aspects of the mental faculties. In this section, we explore what is classified as non-beneficial or *mentis malus* (*akuslala cetasika*). *Mentis malus* is comprised of 5 types of mental malevolence and together has 14 components. Individually and severally, these 14 components of the dark side of the Mind contribute to what the public called unhappiness. The level of unhappiness or mental problem that people experience in their lives depends on the degree and number of these *mentis malus* surfacing in their mental faculties.

The Mind is a machine. By definition, a machine takes in the input of the same kind and produces an output of the same type. For the Mind, the input comes through the six senses: hearing, seeing, smelling, tasting, feeling of bodily touch, and mind-receptor or mental contact. The input are then sound for the hearing organ, form for the sight organ, taste for the tongue, smell for the nose, heat and pressure for the bodily touch, and emotional stimulus for the mind-receptor. The mind is a multi-functional machine capable of processing six different kinds of stimulus and produces six different kinds of output. Each input and output among the six senses has its own receptor; thus, the Mind is more of a factory housing six different machines that receive specific input and produces specific output discretely. These outputs work together with the mental faculties (*mentis facultas*).

The output is packaged into the four building blocks of the Mind. These building blocks consist of (i) form (*ruppa*), (ii) memory (*sanya*), (iii) emotion (*vedhana*), and (iv) synthesis (*sangkhan*). The mental faculties discussed in this paper are found in the synthesis building block of the Mind. In this synthesis block, there are 52 elements of what is called mental faculties or emotions which work with and depends on the Mind to exist. In the packaging process of the mental packaging of the output of the Mind, it is in the synthesis that we find the cause of what may attribute to unhappiness and other causes of mental problem. In this section, we explain the five kinds of mental faculties that attribute to *mentis malus*.

3.1 Lobha or greed as the cause of *mentis malus*

Greed is defined as an intense desire to acquire. A desire to acquire something does not qualify as greed. The desire for the acquisition must be intense in order for it to qualify as greed. There are

three elements of greed: (i) greed as an intense desire to acquire or *lobha*, (ii) holding a wrong view or *dhitti*, and (iii) arrogance or *maana*.

It is true that we cannot obtain all that we desire. Thus, intense desire to acquire things that would not materialize will ultimately lead to disappointment. This feeling of disappointment is a negative mental outlook and if such a feeling is allowed to continued, it will develop into something even more negative. Recall that the mind by its nature cannot stay in one place for too long. The mind arises in one building block and must distinguish and arise in one of the other three building blocks. Under normal condition, as this process continues, a healthy mind is assured. However, when the desire to attain something becomes intense, the mind is forced to focus on that particular desire a longer period of time or as soon as the spark of the mind is extinguished, it is recalled to arise again in that same building block; as this obsessive re-enactment of the mind to be in the same building block and finally comes a moment of truth that what had been desired would not come to fruition, the mind moves from its bingeing state to a new synthesis, a feeling of dejection and disappointment. This negative feeling coupled with the recollection of the desire and its attendant non-fruition recreates more disappointment. As the process continues, all the mental sparks and distinguishing happen in one place: synthesis producing disappointment. This is one cause of mental stress.

Mental stress is defined as tension putting the mind out of balance. Balance of the mind is characterized by the proper function of the mind where it arises and extinguishes constantly and consistently among the four building blocks of the mind. When the mind remains in one building block too long or returns to the same building block too often through the repetition and interaction between memory (*sanya*) and synthesis (*sangkhara*), mental stress or tension occurs. If left untreated, stress may develop into depression. If depression is left untreated, it may lead to depression and ultimately self-destructive action, such as self-inflicted pain and ultimately suicide.

If stress may come from greed and greed is the intense desire to acquire then the cause for stress or depression may be easily identified. If the cause is identified then intervention may be made. In this case, the intervention must start with the re-orientation of the mental outlook. Since the intense desire (*lobha*) is part of the synthesis component of the four building blocks of the mind, the person experiencing stress or depression as the result of greed must be released from that building block of the mind. The mind must be freed from its forced subjugation in the synthesis building block and be allowed to roam freely among the four building blocks according to its nature.

Recall that the four building blocks of the mind are: form, memory, emotion, and synthesis. Greed belongs to synthesis because greed is the intense desire to acquire something that the person does not now have in possession. When this intense desire is created in the synthesis building block, as the mind obeys its law of nature by arising and extinguishing, the person (subject) clings to the second building block called memory and recalls the desire to acquire, the desire was not fulfill and the person becomes disappointed. Not giving up the desire, the person forces the mind to cling to the memory of the desire and engages in the desire under the synthesis building block; thus, the mind is forced to go back and forth between synthesis and memory with disappointment and a feeling of dejection as the consistent outcome. Mental sickness such as stress and depression are the consequences of this artificial and unproductive control of the mind.

The other possible outcome of greed is that the person actually acquires the things that were intensely desired. Would the occurrence of stress or depression foreseeable in such a person? Yes, because greed is defined as intense desire to attain something and that even after the attainment of the object, the person will continue to desire more and with the same or more intensity. That is the nature of greed; greed is an insatiable desire to acquire. There could be no true satisfaction even when the object of desire had been obtained, a new desire will form and the level of intensity rises as before. The only solution is to cut the cycle of desire, attainment and continuing to desire to attain more, by recognizing that this insatiable desire to attain is greed. By accepting the fact that greed leads to disappointment and continuing greed leads to repeated disappointment; in order to

cut the cycle, the person must dissolve greed by turning the attention to other elements or group of mental faculties or emotions.

The second component in this category of negative mental outlook possesses the wrong view point or opinion (*dhitti*). In the scientific community, people whose possess the wrong view are said to have committed Type I error. Type I error occurs when the investigator insist on believing in something that is wrong in spite of the contrary evidence. A person possessing the wrong opinion may produce negative mental outlook because such view is contrary to fact. When faced with reality that is contrary to such a view, the person is forced to accept what is correct, but his insistence to cling to the wrong view will lead him to go on the offensive to insist of being correct, and, at the same time, retreats on the defensive by trying to rationalize that his view is correct despite mounting evidence showing the contrary. This internal conflict will produce a feeling of dejection and self-hate. The holding of the wrong view is thus classified as a negative mental outlook.

The third component of *lobha* is arrogance (*maana*). Arrogance is defined as the feeling of self-aggrandizement at the expense of others. It is a form of selfishness; however, in simple selfishness, the person exploits others for self-interests. Arrogance, on the other hand, is more destructive in that it comes at the expense of others. It is considered unhealthy mental faculties because for the self, arrogance leads to over-confidence; over-confidence leads to recklessness, and ultimately self-endangerment or the estrangement of others. The consequence may be that the arrogant person is faced with ostracism and rejection by his peers and community.

Both the holding the wrong views and being arrogant have their origin in the mind. Among the four building blocks of the mind, the thoughts that gave rise to this kind of mental outlook reside in synthesis. Since the wrong view is contrary to fact, the person holding the wrong view merely synthesizes the opinion and insisting on calling it truthful or correct. As for arrogance, this too comes from the synthesis building block of the mind. The idea that the person is superior to others is an outcome of a mental creation which may not reflect reality. Like greed when the desire is unfulfilled, disappointment is its fruit, arrogance when faced with social rejection or ostracism, disappointment is also laid in wait for an arrogant. When disappointment is the reward of such mental outlook, it should be avoided. To harbor arrogance is to sow the seed of disappointment.

3.2 Dhosa or hatred as the cause of *mentis malus*

Hate is defined as a strong feeling of dislike. As a mental state or mental faculties, hate is a negative sentiment. To say that hate is not definable or irreducible is to engage in self denial (Spencer, 2017). Every human sentiment or mental state had been identified; there are 52 of such emotions called *cetasika*.

Sigmund Freud defined hate as an ego that wishes to destroy the source of its unhappiness; he asserted hate is linked to the question of self-preservation. This view is incorrect and is self-destructive. Freud misunderstood the function and effect of hate. The function of hate is to construct a fictional mental state as part of the person's desire to obtain something but is stopped short of achieving that desire. Hate is a response mechanism in coping with disappointment. The person feeling hate is the subject; the target of which is negative sentiment is aimed becomes the object. The object may or may not be the cause or obstruction of the subject's desire; it is a sub-element of greed (*cupiditas*), but the sentiment of the subject is to aim and channel the negative energy towards the object. This is not “self-preservation” as described by Freud, but it is self destructive in that the subject synthesizes and magnifies an enemy that is unreal and non-existent (*res non existo*). Even in a case where the object may be real, or that obstruction had indeed existed, the sentiment of hate nevertheless is a *de facto* response, not a continuing attempt for self-preservation nor a fight to preserve self interests. Hate is an unhealthy means of self-therapy to heal one's wounded desire. The effect of hate is the creation of a mental state which could neither be found nor supported by objective reality; thus, it is unhealthy for the Mind. As a mental state, hate is a state of mind functioning in a state of less than optimum. The only consolation is that hate, like other mental

state, is a transient state. It is not permanent. It is not correct when someone asserts that hate may not be subsided with the passage of time (Smith, 2016). Since this paper demonstrates that the working of the Mind is discrete, the feeling of hate is the lie and relive of a state of Mind which arises and diminishes. The lingering of this sentiment is not a continuation, but the reliving of an e vent which had passed. It is recalled anew through the power of memory---one of the building blocks of consciousness. By that recollection, the sentiment o hate is relived. Through that reliving does the person reaps the harvest of mental discontent.

Freud is not alone in incorrectly glorifying hate. In some western literature, it has been written that "As compared to magical destruction, aggressive ideas and behaviour take on a positive value, and hate becomes a sign of civilization." (Winnicott, 1973). What defines civilization is "righteousness," not a state of mental psychosis whose root is founded in the deep desire to satisfy the self, but in the process, as the sentiment of hate endures through the repetition of recollection of such a sentiment, hate becomes the source of self destruction for the subject. There are four elements of hate: hatred (*dhosa*), envy (*issa*), stinginess (*macchariya*), and worry, remorse (*kukkucca*).

3.3 Moha or ignorance as the cause of *mentis malus*

A common interpretation of *moha* is "delusion." This interpretation is not meaningful and inaccurate. *Moha* is classified in the greed category. As defined above, greed is the unquenchable desire to acquire something; however, the term "delusion" would not accurately reflect this category of *mentis malus*. Delusion is an idiosyncratic belief that is strongly being held despite contradicting evidence. A more accurate interpretation of *moha* is ignorance (*ignoratio*). In the Buddhist context, ignorance is the antithetical of knowledge or *panya*. Panya is defined as wisdom, knowledge or intelligence. Knowledge or intelligence in Buddhism refers to the knowledge of the four noble truth: (i) suffering (*dhukka*), origin or cause of suffering (*samudhaya*), the end of suffering (*nirodha*), and how suffering could be ended (*marga*). Ignorance, as an antithetical to "knowledge" of the noble truth, refers to not knowing suffering, not knowing the cause of suffering, not knowing that suffering could be ended, and that there is a means or ways for ending suffering.

In a common language, ignorance is defined as the lack of knowledge or lack of understanding. In keeping with the original teaching of knowing and ignorance, then ignorance refers to the mental state that in life there is suffering, its cause, it could be ended and there is a way to end suffering. There are 8 ways to end suffering through righteousness: (i) right view, (ii) right intention, (iii) right speech, (iv) right conduct, (v) right livelihood, (vi) right effort, (vii) right consciousness, and (viii) right concentration or focus.[7] A person believing that life is full of joy may be delusional.

---

[7] 1. สัมมาทิฐิ (ความเห็นที่ถูกต้อง) หมายถึง ความรู้ในอริยสัจ 4

2. สัมมาสังกัปปะ (ความคิดที่ถูกต้อง) หมายถึง ความคิดในการออกจากกาม ความไม่พยาบาท และการไม่เบียดเบียน

3. สัมมาวาจา (วาจาที่ถูกต้อง) หมายถึง การเว้นจากการพูดเท็จ หยาบคาย ส่อเสียด และเพ้อเจ้อ

4. สัมมากัมมันตะ (การปฏิบัติที่ถูกต้อง) หมายถึง เจตนาละเว้นจากการฆ่า โจรกรรม และการประพฤติผิดในกาม

5. สัมมาอาชีวะ (การหาเลี้ยงชีพที่ถูกต้อง) หมายถึง การเว้นจากมิจฉาชีพ

6. สัมมาวายามะ (ความเพียรที่ถูกต้อง) หมายถึง สัมมัปปธาน 4 คือ ความพยายามป้องกันอกุศลที่ยังไม่เกิด ละอกุศลที่เกิดขึ้นแล้ว ทำกุศลที่ยังไม่เกิด และดำรงรักษากุศลที่เกิดขึ้นแล้ว

7. สัมมาสติ (การมีสติที่ถูกต้อง) หมายถึง สติปัฏฐาน 4

People who experience negative emotion and ultimately become stressful are commonly ignorant of the suffering. Not able to recognize that the current state of the mind causes suffering, the person endures the negative mental state that leads to stress. The untreated stress leads to depression. The solution to stress could be recognized the fact that stress is an outcome of ignorance. Stress itself has is cause of suffering. By recognizing this fact is the first step towards exfoliating away the mantle of ignorance. Accepting and practicing the eightfold path will lead to the end of stress and depression because the eightfold path to reorient the mind towards civility, humility, and sensibility. This approach to treatment of mental stress may be far more superior to the conventional practice seen in modern medicine where anti-depressive drugs are used.

3.4 *Dhitthi* or wrong view as the cause of *mentis malus*

Holding the wrong view is a form of mental state which may leads to unwholesome or unhealthy mental condition or state of mind. In general, a wrong view is defined as clinging to any idea or concept in an absolute term. In Buddhism, extreme views are to be avoided; thus, fanaticism is another form of wrong view. Taking the middle path in all views of the world is the correct view. The existence of anything in the world may not be absolute. Absolute existence (*attita*) is not possible since all things must ultimate decay and finally distinguish (*anij-jang*). This transient existence makes the existence of all things impermanent and without permanent self or identity (*anat-ta*). At the end of the spectrum is to claim that nothing exists (*nitthita*). This absolute view of the world is also erroneous and unwholesome. The middle path of seeing the world consists of three components: things exists, remains, and then is extinguished; such is the nature of all things. This is called the middle path (*majima*).

As a mental state, to hold an absolute or extreme view is to sow the seed for disappointment because the world, the realty of the world, is not so. The correct view is one that obeys rationalism and prudence. Rationalism is defined as “any view appealing to reason as a source of knowledge or justification” (Lacey, 1996). By reason, we mean non-extremism. Here, we find the confluence of Buddhism and Western thought because rationalism exerts immense influence upon Western thinking (Lavaert and Schröder, 2016). If guided by rationalism then there should be no extreme view because extremism is irrational and illogical. Fanaticism is an example of wrong view. Fanaticism is self-confirming that the view held by the believer is correct (Postman, 1976). When it is shown that such view is incorrect, fanatics generally take extreme actions to show that their extreme view is correct. Ultimately, fanatics are proved to be wrong and are ostracized from the community of the civilized people.

The correct view is a more prudent view. Prudence requires the avoidance of extreme views. Nothing in the world is absolute. As a mental state and outlook, one should not hold absolute view of any subject. To do so would result in disappointment when it is shown otherwise. For this reason, the wrong view (*Ditthi*) is considered unwholesome. If one can avoid holding a wrong view, one can gain one notch in attaining healthy mind.

3.5 Vijikija or doubt as the cause of *mentis malus*

Doubt is an occasional unwholesome mental state. Occasional means that this type of mental state does not always remain in the Mind of the person. It occurs as a result of reacting to a stimulus. Doubt is a statement or belief or non-belief. It is classified as unwholesome because doubt obstructs the path to knowledge.

In Western philosophy, there is a branch of study called skepticism whose ideology is based on either (1) the denial of possibility of all knowledge or (2) the suspension of judgment due to the

---

8. สัมมาสมาธิ (การมีสมาธิที่ถูกต้อง) หมายถึง ฌาน 4
เมื่อเทียบกับหลักไตรสิกขา องค์มรรคข้อ 1-2 เป็นปัญญา ข้อ 3-4-5 เป็นศีล และข้อ 6-7-8 เป็นสมาธิ
http://www.84000.org/tipitaka/dic/d_item.php?i=293

inadequacy of evidence (Popkin, 2003). This denial of knowledge leads to the conclusion that either nothing exists or if something exists, we could not truly know of its existence (Jones, 1952). Some skeptics may go as far as asserting that the meaning of objects may be constantly changing; therefore, true knowledge is not possible (Popkin, 1967). Thus, one of well known Greek skeptic, Socrates, was reputed to have said he knew nothing or that nothing was worth knowing (Hazlett, 2014). This branch Western philosophy stands at a stark contrast to Buddhist teaching which embraces knowledge. Humans can understand the world they live in, and they can make themselves to be understood.

For Buddhism, true knowledge exists. The four noble truth may be subjected to empirical examination and could stand the test of time because it is self evident and also could be proven. For instance, everything that exists in the world arises as its first coming forth. Thereafter, it remains in existence, and then is extinguished. This birth, remains in existence, and death represents the cycle of existence of all things, living and non-living. It is further argued that if an object's existence is impermanent then it may be the cause of human suffering as we cling to it (object of desire) as it ultimately will diminish. Thus the logic of the four noble truth follows: *where there is suffering, there is a cause, where there is a cause, there is a cessation, and there is a method of how to end that suffering*. Knowledge is capable of being ascertained. Doubt is seen as one of fifty-two possible mental states. Unlike Western philosophy of skepticism, Buddhist philosophy treats skepticism as an unwholesome state of mind. Instead of a branch of knowledge, skepticism is seen as an obstruction to knowledge.

4.0 SOBHANA CETASIKA (WHOLE & HEALTH EMOTIONS)

Recall that Buddhist teaching categorizes mental faculties into 52 elements. These 52 elements are further divided into four sub-categories: (i) general, (ii) occasional, (iii) unwholesome or unhealthy, and (iv) wholesome or beautiful, mental faculties. This section explains the last group of mental faculties (wholesome) which is comprised of (a) public or universal, (b) righteousness, (c) limitless and (d) wisdom.

4.1 Sadharana (public or universal) as the cause of *mentis bonus*

There are 19 distinct mental faculties that are classified as universal cause for healthy mental state (*mentis bonus*). Where there are only 14 elements of mental faculties which are responsible for unhealthy mind (*mentis malus*), the 19 elements of *mentis bonus* is provides hope for treatment of mental distress. Firstly, there are more "good" than there are "bad" mental states. By replacing each unhealthy mental state with a healthy one, mental distress may be treated. This treatment is be accomplished with "mind management" instead of external intervention, such as antidepressant chemicals, such as: sertraline (Zoloft), fluoxetine (Prozac, Sarafem), citalopram (Celexa), escitalopram (Lexapro), paroxetine (Paxil, Pexeva, Brisdelle), or fluvoxamine (Luvox) whose side effect may include *nausea; increased appetite and weight gain; loss of sexual desire and other sexual problems, such as erectile dysfunction and decreased orgasm fatigue and drowsiness; insomnia; dry mouth; blurred vision; constipation; dizziness; agitation; and irritability*. Secondly, mental stress or depression treatment may simply be reduced to no more than "mind management." This mind management approach to treatment of mental distress include the recognition of the 4 basic building block of the mind and replace the 14 unhealthy mental states with the 25 healthy ones. The 19 mental states are universal or general that could be recognized and experience by all persons without special training. They are listed below with their corresponding English equivalence.

1. Saddhā	Confidence
2. Sati	Mindfulness
2. Hiri	Moral shame
3. Ottappa	Moral fear

3. Alobha	Non-greed
4. Adosa	Non-hatred
5. Tatramajjhattatā	Equanimity
6. Kāyapassaddhi	Tranquility (of mental factors)
7. Cittapassaddhi	Tranquility (of consciousness)
8. Kāyalahutā	Lightness (of mental factors)
9. Cittalahutā	Lightness (of consciousness)
10. Kāyamudutā	Pliancy (of mental factors)
11. Cittamudutā	Pliancy (of consciousness)
12. Kāyakammaññatā	Adaptability (of mental factors)
13. Cittakammaññatā	Adaptability (of consciousness)
14. Kāyapāguññatā	Proficiency (of mental factors)
15. Cittapāguññatā	Proficiency (of consciousness)
16. Kāyujjukatā	Rectitude (of mental factors)
17. Cittujjukatā	Rectitude (of consciousness)

In addition to the 19 universal mental states, there are other occasional or specific healthy mental states which include (i) abstinence, (ii) infinity, and (wisdom). There are three kinds of abstinence, namely right speech (*samma vaja*), right action (*samma kammanta*), and right livelihood (*samma ajiva*). There are two type of infinite mental state, namely compassion (*karuna*), and sympathetic joy (*mudita*). As for wisdom, there is only one type and has no sub-elements.

There are 14 mental states or emotion that a person should recognize and avoid. These 14 elements of *mentis malus* are:

1. Moha	Delusion
2. Ahirika	Shamelessness
3. Anottappa	Moral fearlessness
4. Uddhacca	Restlessness
5. Lobha	Greed
6. Diṭṭhi	Wrong view
7. Māna	Conceit
8. Dosa	Hatred
9. Issā	Envy
10. Macchariya	Stinginess
11. Kukkucca	Worry, remorse
12. Thīna	Sloth, laziness
13. Middha	Torpor, tiredness
14.Vicikicchā	Skeptical doubt

Since the mind function in such fast speed that it is nearly impossible to anticipate each mental state before it occur, but only through recognition after it had already disintegrated. A thought may arise, we are able to recognize it only after it has been extinguished and new thought arises in its place. Thus, the in order to avoid a particular type of thought of mental state is through (i) recognition, and (ii) avoidance. The recognition is the recognition after it had extinguished. The avoidance is the avoidance of not to recall it through memory (*sanya*).

4.2 Viratti (abstinence) as the cause of *mentis bonus*

Abstinence means refraining from doing. Since we are talking about the mental state, the refraining is about refraining from doing something so that we could maintain a benevolent mental state. “Abstinence” is about refraining from doing bad conduct or refraining from entertaining bad thoughts (14 elements of unhealthy mental states) in order to attain and preserve a benevolent

mental state. Abstinence mental faculty or emotion consists of three elements: right speech (*Sammā vācā*), right action (*Sammā kammanta*), and right livelihood (*Sammā ājīva*).

Right speech consists of refraining from telling lies, use of profanity, innuendo, and raving. Right action consists of refraining from killing, stealing, committing adultery. Right livelihood means to earn an honest living, and refraining from wrongful livelihood. These three types of refraining conducts constitute abstinence. Each type of refraining seems to refer to conduct, rather than a state of mind. However, all refraining in this group of *bonus mentis* has their root in the mind, i.e. intent. Since they are intentional acts, by refraining from their commission, the mind is put at state of abstinence of doing unwholesome action or thought. People who refrain from engaging in wrong speech, wrong action and wrong livelihood are said to harbor good mental state. Since all action begins its course in the mind, by refraining from such actions, the mind is not polluted. This state of mind or emotion is considered to be benevolent.

4.3 Appamanya (limitless) as the cause of *mentis bonus*

There is a group of mental states which could not be counted. These are compassion (Karuṇā) and sympathetic joy (Muditā). We cannot quantify compassion. Although there might be a level or degree of compassion, such an attempt to quantify what is truly limitless is an artificial construct. Similarly, the joy of sympathizing with another human being is also not quantifiable. When we express for having witness others being happy, this mental state connotes the purity of the heart and mind because our emotion is not clouded by envy or jealousy. Compassion and sincerity could not be measured with quantifiable scale.

What does it cost to have compassion for another living being? Compassion does not an input and output process. Compassion is the desire to alleviate other's suffering (Jimenez, 2011). This attempt to alleviate the suffering of other may come in a form of warmth and care (Nanda and Santosh, 2015). In the western literature, the expression of compassion is said to be hierarchical, paternalistic and controlling in responses (Gilbert, 2001). One western source claims that compassion is a variation of love or sadness (Shaver et al., 1987). It is recognized as an emotional state (Bowlby, 1983; Haidt, 2003; Keltner *et al.*, 2006). It links the person expressing compassion with the one who is suffering (Goetz *et al.*, 2010; Ekma, 2003). One source claims that the rationale is that people emulate the emotion of other people around them (Hatfield and Cacioppo, 1993). This view is not genuine since compassion is an expression of sincere understanding of other people's suffering. The purpose of expression compassion is to lessen the suffering of the other person who is suffering by showing the understanding of such sufferance. It is not a mere expression of fake emotion resulted from emulation. Hence, the more a person knows about human conditions and their sufferance, the more readily that person is to express compassion for his fellow beings (Cassell, 2009). Compassion may have the effect of inducing the feeling of kindness and forgiveness; thus, the presence of compassion generally reduces the chance for violence (Goertz *et al.*, 2010).

4.4 Panya (wisdom) as the cause of *mentis bonus*

Finally, wisdom is a benevolent mental state. The term "Paññindriya" or Wisdom is a mental faculty or state of mind requires a comparative analysis on how western writers see wisdom as oppose to how is wisdom being viewed under Buddhism.

Wisdom is unbiased knowledge (Grossmann, 2017). An example is wisdom is virtue and ethics (Staudinger and Glück; 2011; Walsh, 2015). Western writing differentiates wisdom from emotion (Grossmann *et al.*, 2018). However, in Buddhist philosophy, wisdom is one form of emotional state. Wisdom is a subject of study in modern psychology (Sternberg, 1985). "[T]here is an overlap of the implicit theory of wisdom with intelligence, perceptiveness, spirituality and shrewdness, it is evident that wisdom is an expertise in dealing with difficult questions of life and adaptation to the complex requirements." (Brown and Greene, 2006). Some sources assert that there is a psychological process that underlies wisdom (Bluck and Glück, 2005). This view is consistent

with the Buddhist teaching since in Buddhism wisdom is an emotional state. Nevertheless, among western literature, psychological definition of wisdom varies (Staudinger and Glück, 2011). Despite the variation and uncertainty of the concept of wisdom, there is a consensus among western writers that "wisdom" is a reflection and judgment about critical life matters (Baltes and Staudinger, 2000). Wisdom is the state of being wise. Wisdom is not the same as IQ (Grossmann *et al.*, 2010); it is a different kind of intelligence (Staudinger *et al.*, 1997). A wise reflection upon other people's life problem is one way of looking at wisdom (Grossman and Kross, 2017).

Can wisdom be measured? It has been argued that wisdom could be measured either as a form stable personality or how the person judge or evaluate problems in different context (Grosmannm 2017). However, the use of questionnaire to assess wisdom has been criticized as having biased response (Brienza *et al.*, 2017; Taylor *et al.*, 2011). This claim itself, if well-founded, is inconsistent with the pretext of wisdom. By its very nature, wisdom is an objective knowledge, absent of bias (Glück *et al.*, 2013). To assert that there is response bias in a survey to test or assess wisdom is argumentative and self-defeating. Regardless of the argument and counter-argument in the measurement of wisdom, research had shown that the outcome of measuring wisdom is context dependent (Grossmann, 2017). For example, this contextual difference may come from culture (Grossmann *et al.*, 2012), and age (Harter, 2004; Orwoll and Perlmutter 1990).

Wisdom is knowledge of what is good and bad in life. In Buddhist teaching, wisdom may be obtained through three sources: (i) listening to someone know is wise (suta-maya-panya); (ii) thinking (*jinta-maya-panya*); and (iii) learning or doing (*pavana-maya-panya*) (Tipitaka, vol. 11). In order to accomplish any one of the three sources of wisdom, the person must learn to be an objective observer. To maintain objectivity, one must use three rule of observation: (a) that is not mine (*netang-mama*), (b) that is not me (*neso-hamassami*), and (c) that is not about me (*na-meso atta*). As an observer, the person must not identify himself/herself with the object of observation. To distance oneself from the event, one achieves the first element of objectivity. Secondly, the observer must not claim possessory interests or taking any form of advocacy in the event or object of observation. By not claiming possessory interest in the event, the event could be observed objectively. Thirdly, the observer must not internalize the event nor identify with the event.

The analytical approach to wisdom consists of 4 steps: (i) recognition of the event, such as human suffering (*dukkha*), (ii) causation of the event (*samudha-ya*), (iii) the diminishing of the event (*nirodha*), and (iv) method of obtain diminishment of the event (*nidhoda pattipata*) by the 8 fold paths (*maggha*) (Tipitaka, vol. 19). The 8 fold paths to righteousness are: (i) right view, (ii) right intention, (iii) right speech, (iv) right conduct, (v) right livelihood, (vi) right effort, (vii) right consciousness, and (viii) right concentration or focus.

5.0 ANALYSIS AND DISCUSSION

In this first part of a two parts series, we outline the mental faculties responsible for mental stress. We note that mental state is part of the functioning of the min. The mind functions by clinging to four building blocks, namely for, emotion, memory and synthesis. The state of happiness or distress lies in the synthesis block of the mind. This synthesis consists of what is called "mental faculties" which consists of 52 different types of emotions. There are 14 types of emotions that may contribute to mental distress. In contrast, there are 25 healthy mental states which a person could use to counter unwholesome or unhealthy mental states. In the second paper, we will use the 14 elements of unwholesome mental states as indicators to measure mental distress.

5.1 Joy and happiness

Happiness may be defined as pleasant emotional states, such as joy, amusement, satisfaction, gratification, euphoria, and triumph (Algoe and Haidt, 2009). In a broader sense, happiness is to live life in a satisfying way (Deci, 2006). This satisfaction may come from many sources, such as encountering unexpected positive event, (Cosmides and Tooby, 2000), or seeing love ones (Lewis, 2016). The source of happiness may be both internal and external in origin (Seligman (2004).

Happiness is not the ultimate goal; it must be balanced with the meaning of life (Baumeister *et al.*, 2013; Abe, 2016). Some culture advocates a balanced life, and not advocate to maximize happiness (Joshanloo and Weijers, 2014; Hornsey *et al.*, 2018).

The importance of happiness may be seen through historical evidence of modern politics. For instance, Thomas Jefferson claimed that the pursuit of happiness is a universal right of people (Schelesinger, 1964). Happiness has been used as an indicator to measure how well the government is doing its job for the country (Tolumitsu, 2017). Subjective Happiness Scale was used to measure happiness (Lyubomirsky and Lepper, 1999). Satisfaction with Life Scale (Diener *et al.*, 1985). World happiness report uses the Cantril Scale ranging from 0 to 10 (Levin and Currie, 2014). These empirical attempts to measure happiness showed that happiness appears to be stable over time (Baumeister *et al.*, 2013; Costa *et al.*, 1987).

Happiness or joy is a mental state that is created in the mind by its function. It is not a state of nature where happiness or joy is continuous and lasting; rather, the mind experiences a state of joy by not encountering the 14 distressful state of mind. When the mind finds mental unity (*mentis Concordia*), it repeats the replay of that state by moving between synthesis building block, memory building blocks, and emotion or sentiment building block. These are abstract building blocks of the mind; thus, happiness is an abstract concept. How happiness is achieve, the mind has to work in moving around three out of four building blocks. By discovering how the mind works through its building blocks, there is no secret in finding a joyful mental state which we commonly called happiness.

Thus, what we have seen in the western literature about attempts to measure happiness had been so far failed attempts. How long does happiness remains when it arises, and at what kevel does happiness manifest itself? These types of question may be meaningful only if they are put into context of the 4 basic building blocks of the mind. In this part 1 of two parts paper, we assert that happiness is a mental state recognizable only as an after fact (*de facto*), not instantaneous since the person's ability to recognize an event created by the mind is much slower that the occurrence of the event. Any measurement of happiness, therefore, is a measurement of the recollection of the event, not the event itself. Since happiness is a mental state whose existence or occurrence is discrete, any longitudinal study of attempts to monitor the state of happiness over time is a failed study. Since happiness is a state of mind that exists and disintegrate so quickly, the observe must be a good observer. In the second part of this paper, we anticipate quantitative modeling of the functioning of the mind and how could such proposed model be used for treating mental stress and depression.

5.2 Mental stress and depression

Stress is defined as mental strain. Stress may lead to depression and other health problems (Sapolsky, 2004). One mechanism to cope with stress is positive adaptation (Gibbon, 2012). Four types of stress had been identified (Selye, 1974): good stress, bad stress, hyper-stress and hypo-stress. One coping mechanism is to balance the hyper and hypo-stress (Selye, 1983). Good stress (eustress) may lead to good feeling or euphoria (Selye, 1975). When an external shock is experienced by a person as a source of euphoria, this may be seen as positive stress (Fevre *et al.*, 2006). Whether the factor contributed to stress depends on the subjective interpretation of the person (Hargrove *et al.*, 2013). Major life event may lead to stress (Teo and Fam, 2018). The chronic occurrence of these life changing events may lead to health problems (Cohen *et al.*, 1998).

Positive life changing event may help predict mental stress (Jeronimus *et al.*, 2014; Jeronimus *et al.*, 2013). A person's perception of stressor modulates mental stress (Alwin *et al.*, 2014). There had been attempts to measure stress level produced by various life changing events (Holmes and Rahe, 1967).

From the Buddhist teaching, stress is internal in nature. This intrinsic cause of mental comes from 14 factors; these factors had been identified in this paper as: *delusion; shamelessness; moral fearlessness; restlessness; greed; wrong view; conceit; hatred; envy; stinginess; worry, remorse; sloth, laziness; torpor, tiredness; and skeptical doubt*. The key to avoid stress or mental distress is

to recognize these 14 factors in our emotion or mental state and refrain from entertaining or allowing such mental states to fester in the mind. Instead, the person should entertain or experience the 25 types of healthy mental; states that may lead to a state of joy (Index 2).

7.0 CONCLUSION

Although this paper is not a religious study, since the mind and mental states had been studied by Buddha in 4th century B.C. and much of the discussion in this paper is based on Buddha's teaching on the mind and emotion, we relied heavily on Buddhist concept. The purpose of this paper is to explain mental or emotional states in order to identify particular types of emotional states that are responsible for mental distress and depression. According to Buddha's treatise on the mind, there are 52 distinct mental or emotional states. We identified 14 types of mental states that are classified as unwholesome mental faculties. We assert that by identifying and find the means to dissolve these 14 mental states through the use of meditation focusing on other remaining 38 mental faculties, stress and depression could be effectively treated without the use of chemicals, such as anti-depressant drugs. This paper is the first installment of a two installment series. In this part 1, we identified 14 elements of unwholesome mental states that are responsible for stress and depression. In part 2, we will construct a survey to measure these 14 mental states and identify which elements of the remaining 38 mental states could be harnessed and used to eliminate or lessen the effect of these 14 unwholesome emotions.

REFERENCES

Abe, Jo Ann A. (2016). "A longitudinal follow-up study of happiness and meaning-making." *The Journal of Positive Psychology*. **11** (5): 489–498. doi:10.1080/17439760.2015.1117129.

Adam, C. and Tannery, P. (eds.), *Oeuvres de Descartes X*, 524 (1908). https://archive.org/stream/oeuvresdedescar10desc#page/524/mode/2up

Aldwin, Carolyn M; Jeong, Yu-Jin; Igarashi, Heidi; Choun, Soyoung; Spiro, Avron (2014). "Do hassles mediate between life events and mortality in older men?" *Experimental Gerontology*. **59**: 74–80. doi:10.1016/j.exger.2014.06.019. PMC 4253863. PMID 24995936.

Algoe, Sara B.; Haidt, Jonathan (2009). "Witnessing excellence in action: the 'other-praising' emotions of elevation, gratitude, and admiration." *The Journal of Positive Psychology*. **4** (2): 105–27. doi:10.1080/17439760802650519. PMC 2689844. PMID 19495425.

Antony, Michael V. (2001). "Is consciousness ambiguous?" *Journal of Consciousness Studies*. **8**: 19–44.

Baltes, Paul B.; Staudinger, Ursula M. (2000). "Wisdom: A metaheuristic (pragmatic) to orchestrate mind and virtue toward excellence." *American Psychologist*. **55**(1): 122–136. doi:10.1037/0003-066X.55.1.122.

Başar, Erol (2010). *Brain body mind oscillations in scope of uncertainty principle*. New York: Springer. p. 5. ISBN 978-1441961365.

Baumeister, Roy F.; Vohs, Kathleen D.; Aaker, Jennifer L.; Garbinsky, Emily N. (2013). "Some key differences between a happy life and a meaningful life." *The Journal of Positive Psychology*. **8** (6): 505–516. doi:10.1080/17439760.2013.830764.

Bluck, S.; Glück, J. (2005). "From the Inside Out: People's Implicit Theories of Wisdom." *A handbook of wisdom: Psychological perspectives*. New York, US: Cambridge University Press. pp. 84–109. doi:10.1017/CBO9780511610486.005. ISBN 9780511610486.

Bowlby, John (1983). *Attachment: Attachment and Loss Volume One*. New York, NY: Basic Books.

Brienza, J.P.; Kung, F.Y.H.; Santos, H.; Bobocel, D.R.; Grossmann, I. (2017). "Wisdom, Bias, and Balance: Toward a Process-Sensitive Measurement of Wisdom-Related Cognition.: *Journal of Personality and Social Psychology*. **115**(6): 1093–1126. doi:10.1037/pspp0000171. PMID 28933874.

Brown, S. C.; Greene, J. A. (2006). "The Wisdom Development Scale: Translating the conceptual to the concrete." *Journal of College Student Development*. **47**: 1–19. CiteSeerX 10.1.1.502.7954. doi:10.1353/csd.2006.0002.

Cambridge Dictionary. https://dictionary.cambridge.org/dictionary/english/consciousness

Cassell, Eric (2009). *Oxford Handbook of Positive Psychology* (2 ed.). New York, New York: Oxford University Press. pp. 393–403. ISBN 978-0-19-518724-3.

Cassin, Barbara (2014). *Dictionary of Untranslatables. A Philosophical Lexicon*. Princeton University Press. p. 176. ISBN 978-0-691-13870-1.

Churchland, Paul (1981). "Eliminative Materialism and the Propositional Attitudes." *Journal of Philosophy*. **78** (2): 67–90. doi:10.2307/2025900. JSTOR 2025900.

Churchland, Patricia (1986). *Neurophilosophy: Toward a Unified Science of the Mind-Brain*. MIT Press. ISBN 978-0-262-03116-5.

Clark, Andy (2014). *Mindware*. 198 Madison Avenue, New York, 10016: Oxford University Press. pp. 14, 254–256. ISBN 978-0-19-982815-9.

Cohen, Sheldon; Frank, Ellen; Doyle, William J; Skoner, David P; Rabin, Bruce S; Gwaltney, Jack M (1998). "Types of stressors that increase susceptibility to the common cold in healthy adults." *Health Psychology*. **17** (3): 214–23. doi:10.1037/0278-6133.17.3.214. PMID 9619470.

Cosmides, Leda; Tooby, John (2000). "Evolutionary Psychology and the Emotions". In Lewis, Michael; Haviland-Jones, Jeannette M. Handbook of emotions (2 ed.). New York [u.a.]: Guilford Press. ISBN 978-1-57230-529-8. Archived from the original on 2017-04-30. Retrieved 2017-04-02.

Costa, Paul T.; McCrae, Robert R.; Zonderman, Alan B. (August 1987). "Environmental and dispositional influences on well-being: Longitudinal follow-up of an American national sample." *British Journal of Psychology*. **78** (3): 299–306. doi:10.1111/j.2044-8295.1987.tb02248.x.

Craig, Edward (1998). "Consciousness." *Routledge Encyclopedia of Philosophy*. Routledge. ISBN 978-0-415-18707-7.

Davidson, Donald (1980). *Essays on Actions and Events*. Oxford University Press. ISBN 978-0-19-924627-4.

Deci, Edward L.; Ryan, Richard M. (2006). "Hedonia, eudaimonia, and well-being: an introduction." *Journal of Happiness Studies*. **9** (1): 1–11. doi:10.1007/s10902-006-9018-1.

Delgadom James M.R. (1969). *Physical control of the mind; towards a psycho civilized society*. Toronto: Fitzhenry & Whiteside Limited. p. 25.

Dennett, Daniel (1998). *The intentional stance*. Cambridge, Mass.: MIT Press. ISBN 978-0-262-54053-7.

Diener, Ed; Emmons, Robert A.; Larsen, Randy J.; Griffin, Sharon (1985). "The Satisfaction With Life Scale." *Journal of Personality Assessment*. **49** (1): 71–75. doi:10.1207/s15327752jpa4901_13. PMID 16367493.

Farah, Martha J.; Murphy, Nancey (February 2009). "Neuroscience and the Soul." *Science*. **323** (5918): 1168. doi:10.1126/science.323.5918.1168a. PMID 19251609.

Ekman, Paul (2003). *Emotions Revealed: Recognizing Faces and Feelings to improve communication and emotional life*. New York, NY: Henry Holt & Company.

Farthing G. (1992). *The Psychology of Consciousness*. Prentice Hall. ISBN 978-0-13-728668-3.

Fevre, Mark Le; Kolt, Gregory S.; Matheny, Jonathan (1 January 2006). "Eustress, distress and their interpretation in primary and secondary occupational stress management interventions: which

way first?" *Journal of Managerial Psychology*. **21** (6): 547–565. doi:10.1108/02683940610684391.

Fins, J.J., Schiff, N.D., and Foley, K.M. (2007). "Late recovery from the minimally conscious state: ethical and policy implications." *Neurology*. **68** (4): 304–307. doi:10.1212/01.wnl.0000252376.43779.96. PMID 17242341.

Freud, S. (1915). "The instincts and their vicissitudes," in *On Metapsychology* (PFL 11) p. 135-5.

Gilbert, Paul (2010). *The Compassionate Mind: A New Approach to Life's Challenges*. New Harbinger Publications. ISBN 978-1-57224-840-3.

Gilbert Ryle (1949). *The Concept of Mind*. University of Chicago Press. pp. 156–163. ISBN 978-0-226-73296-1.

Gibbons, C. (2012). "Stress, positive psychology and the National Student Survey." *Psychology Teaching Review*. **18** (2): 22–30.

Goetz, J; D Keltner; E Simon-Thomas (2010). "Compassion: An evolutionary analysis and empirical review." *Psychological Bulletin*. **136**(3): 351–374. doi:10.1037/a0018807. PMC 2864937. PMID 20438142.

Goetz, Jennifer; Dacher Kelter; Emiliana Simon-Thomas (2010). "Compassion: An Evolutionary Analysis and Empirical Review." *Psychological Bulletin*. **136**(3): 351–374. doi:10.1037/a0018807. PMC 2864937. PMID 20438142.

Glück, J.; König, S.; Naschenweng, K.; Redzanowski, U.; Dorner-Hörig, L.; Straßer, I; Wiedermann, W (2013). "How to measure wisdom: Content, reliability, and validity of five measures." *Frontiers in Psychology*. **4**: 405. doi:10.3389/fpsyg.2013.00405. PMC 3709094. PMID 23874310.

Grossmann, Igor; Oakes, Harrison; Santos, Henri C. (2018). "Wise Reasoning Benefits from Emodiversity, Irrespective of Emotional Intensity." *Journal of Experimental Psychology: General*. doi:10.1037/xge0000543. PMID 30688474 – via PsyArXiv.

Grossmann, I. (2017). "Wisdom in context." *Perspectives on Psychological Science*. **12**(2): 233–257. doi:10.1177/1745691616672066. PMID 28346113.

Grossmann, I.; Na, J.; Varnum, M.E.; Park, D.C.; Kitayama, S.; Nisbett, R.E. (2010). "Reasoning about social conflicts improves into old age." *Proceedings of the National Academy of Sciences*. **107**(16): 7246–50. Bibcode:2010PNAS..107.7246G. doi:10.1073/pnas.1001715107. PMC 2867718. PMID 20368436.

Grossmann, Igor; Kross, Ethan (2017). "Exploring Solomon's Paradox: Self-distancing eliminates the self-other asymmetry in wise reasoning about close relationships in younger and older adults." *Psychological Science*. **25**(8): 1571–1580. doi:10.1177/0956797614535400. PMID 24916084.

Grossmann, I. (2017). "Wisdom in context." *Perspectives on Psychological Science*. **12**(2): 233–257. doi:10.1177/1745691616672066. PMID 28346113.

Grossmann, I. (2017). "Wisdom in context." *Perspectives on Psychological Science*. **21**(12): 1254–1266. doi:10.1177/1745691616672066. PMID 28346113.

Grossmann, I.; Karasawa, M.; Izumi, S.; Na, J.; Varnum, M.E.; Kitayama, S; Nisbett, R.E (2012). "Aging and wisdom: Culture matters." *Psychological Science*. **23**(10): 1059–1066. doi:10.1177/0956797612446025. PMID 22933459.

Güven Güzeldere (1997). Ned Block, Owen Flanagan, Güven Güzeldere, eds. *The Nature of Consciousness: Philosophical debates*. Cambridge, MA: MIT Press. pp. 1–67.

Hargrove, M. B.; Nelson, D. L.; Cooper, C. L. (2013). "Generating eustress by challenging employees: Helping people savor their work." *Organizational Dynamics*. **42**: 61–69. doi:10.1016/j.orgdyn.2012.12.008.

Hart, W.D. (1996) "Dualism," in Samuel Guttenplan (org), *A Companion to the Philosophy of Mind*, Blackwell, Oxford, 265–267.

Harter, Andrew C. (2004). "8." In Peterson, Christopher; Seligman, Martin E. P. *Character Strengths and Virtues: A Handbook and Classification*. Oxford: Oxford University Press. pp. 181–196. ISBN 978-0-19-516701-6.

Hatfield, Elaine; John Cacioppo; Rapson, Richard L. (1993). "Emotional Contagion." *Current Directions in Psychological Science*. **2**(3): 96–99. doi:10.1111/1467-8721.ep10770953.

Haidt, Jonathan (2003). *The Moral Emotions*. Oxford: Oxford University Press. pp. 852–870.

Hazlett, Alan (2014). *A Critical Introduction to Skepticism*. London: Bloomsbury, 2014, p. 5.

Heinämaa, S., Lähteenmäki, Remes, V. Pauliina (eds.) (2007). *Consciousness: from perception to reflection in the history of philosophy*. Springer. pp. 205–206. ISBN 978-1-4020-6081-6.

Hennig, Boris (2007). "Cartesian Conscientia." *British Journal for the History of Philosophy*. 15 (3): 455–484. doi:10.1080/09608780701444915.

https://www.tandfonline.com/doi/abs/10.1080/09608780701444915

Holmes, T.H.; Rahe, R.H. (1967). "The Social Readjustment Rating Scale." *J. Psychosom Res.* **11** (2): 213–8. doi:10.1016/0022-3999(67)90010-4. PMID 6059863.

Hornsey, Matthew J.; Bain, Paul G.; Harris, Emily A.; Lebedeva, Nadezhda; Kashima, Emiko S.; Guan, Yanjun; González, Roberto; Chen, Sylvia Xiaohua; Blumen, Sheyla (2018). "How Much is Enough in a Perfect World? Cultural Variation in Ideal Levels of Happiness, Pleasure, Freedom, Health, Self-Esteem, Longevity, and Intelligence." *Psychological Science*. **29** (9): 1393–1404. doi:10.1177/0956797618768058. PMID 29889603.

Israel, Richard; North, Vanda (2010). *Mind Chi Re-wire Your Brain in 8 Minutes a Day; Strategies for Success in Business and Life*. Chichester: John Wiley & Sons. p. 12. ISBN 978-1907321375

Jeronimus, B. F; Ormel, J; Aleman, A; Penninx, B. W. J. H; Riese, H (2013). "Negative and positive life events are associated with small but lasting change in neuroticism." *Psychological Medicine*. **43** (11): 2403–15. doi:10.1017/S0033291713000159. PMID 23410535.

Jeronimus, Bertus F; Riese, Harriëtte; Sanderman, Robbert; Ormel, Johan (2014). "Mutual reinforcement between neuroticism and life experiences: A five-wave, 16-year study to test reciprocal causation." *Journal of Personality and Social Psychology*. **107** (4): 751–64. doi:10.1037/a0037009. PMID 25111305.

Jones, W.T. (1952). *A History of Western Philosophy*. New York: Harcourt, Brace, 1952, p. 60 n. 45.

Joshanloo, Mohsen; Weijers, Dan (2014). "Aversion to Happiness Across Cultures: A Review of Where and Why People are Averse to Happiness." *Journal of Happiness Studies*. **15** (3): 717–735. doi:10.1007/s10902-013-9489-9.

Karunamuni N, Weerasekera R. (Jun 2017). "Theoretical Foundations to Guide Mindfulness Meditation: A Path to Wisdom." Current Psychology (Submitted manuscript). doi:10.1007/s12144-017-9631-7.

Karunamuni N.D. (May 2015). "The Five-Aggregate Model of the Mind." SAGE Open. 5 (2): 215824401558386. doi:10.1177/2158244015583860.

Keltner, Dacher; Jonathan Haidt; Michelle Shiota (2006). *Social Functionalism and the Evolution of Emotions*. New York: Psychology Press. pp. 115–142.

Kim, J. (1995). Honderich, Ted, ed. *Problems in the Philosophy of Mind*. Oxford Companion to Philosophy. Oxford: Oxford University Press.

Klopf, Harry (June 1975). "A comparison of natural and artificial intelligence." *ACM SIGART Bulletin* (**52**): 11–13. doi:10.1145/1045236.1045237.

Koch, Christof (July 2009). "Do Not Underestimate Science." *Science*. 325 (5939): 392. Bibcode:2009Sci...325..392K. doi:10.1126/science.325_392b. PMID 19628839

Lacey, A.R. (1996), *A Dictionary of Philosophy*, 1st edition, Routledge and Kegan Paul, 1976. 2nd edition, 1986. 3rd edition, Routledge, London, UK, 1996. p. 286

Lavaert, Sonja; Schröder, Winfried (eds.): *The Dutch Legacy: Radical Thinkers of the 17th Century and the Enlightenment*. (Leiden: Brill, 2016)

Levin, K. A.; Currie, C. (2014). "Reliability and Validity of an Adapted Version of the Cantril Ladder for Use with Adolescent Samples." *Social Indicators Research*. **119** (2): 1047–1063. doi:10.1007/s11205-013-0507-4.

Lewis, Michael (2016-07-12). "Self-Conscious emotions." *In* Barrett, Lisa Feldman; Lewis, Michael; Haviland-Jones, Jeannette M. *Handbook of Emotions* (Fourth ed.). Guilford Publications. p. 793. ISBN 978-1-4625-2536-2. Retrieved 1 April 2017.

Lewis, C.S. (1990). "Ch. 8: Conscience and conscious." Studies in words. Cambridge University Press. ISBN 978-0-521-39831-2.

Locke, John. "An Essay Concerning Human Understanding (Chapter XXVII)." Australia: University of Adelaide. https://ebooks.adelaide.edu.au/l/locke/john/l81u/B2.27.html

Louis, Jaucourt, chevalier de. "Consciousness." *The Encyclopedia of Diderot & d'Alembert Collaborative Translation Project*. Translated by Scott St. Louis. Ann Arbor: Michigan Publishing, University of Michigan Library, 2014. Originally published as "Conscience," *Encyclopédie ou Dictionnaire raisonné des sciences, des arts et des métiers*, 3:902 (Paris, 1753).

Lyubomirsky, Sonja; Lepper, Heidi S. (February 1999). "A Measure of Subjective Happiness: Preliminary Reliability and Construct Validation." *Social Indicators Research*. **46** (2): 137–55. doi:10.1023/A:1006824100041. JSTOR 27522363.

Molenaar, G. (1969). "Seneca's Use of the Term Conscientia." *Mnemosyne*. **22** (2): 170–180. doi:10.1163/156852569x00670. https://brill.com/abstract/journals/mnem/22/2/article-p170_6.xml

Nanda Kishore, Reddy; Santosh, Ajmera (2015). *Ethics, Integrity and Aptitude*. McGraw-Hill Education. p. 146. ISBN 978-93-5134-236-6.

Orwoll, L.; Perlmutter, M. (1990). R. J. Sternberg, ed. *Wisdom: Its nature, origins, and development*. New York: Cambridge University Press. pp. 160–177. ISBN 978-0-521-36718-9.

Oxford Dictionary. https://en.oxforddictionaries.com/definition/consciousness

Popkin, Richard Henry, (2003). *The history of scepticism: from Savonarola to Bayle*. Popkin, Richard Henry, 1923- (Rev. and expanded ed.). Oxford: Oxford University Press. ISBN 9780195355390. OCLC 65192690.

Postman, Neil (1976). "Fanaticism." Crazy Talk, Stupid Talk. pp. 104–112. ISBN 0-440-01554-5.

Putnam, Hilary (1967). "Psychological Predicates" in W.H. Capitan and D.D. Merrill, eds., *Art, Mind and Religion Pittsburgh*: University of Pittsburgh Press.

Richard H. Popkin, "Skepticism," in Paul Edwards, ed., *The Encyclopedia of Philosophy*, vol. 7. New York: Macmillan, 1967, p. 449.

Robert van Gulick (2004). "Consciousness." *Stanford Encyclopedia of Philosophy*. https://plato.stanford.edu/entries/consciousness/

Sapolsky, Robert M. (2004). *Why Zebras Don't Get Ulcers*. 175 Fifth Ave, New York, N.Y.: St. Martins Press. pp. 37, 71, 92, 271. ISBN 978-0-8050-7369-0.

Searle, John (2005). "Consciousness." In Honderich T. *The Oxford companion to philosophy*. Oxford University Press. ISBN 978-0-19-926479-7.

Searle, John (2001). *Intentionality. A Paper on the Philosophy of Mind. Frankfurt: Nachdr. Suhrkamp*. ISBN 978-3-518-28556-5.

Seligman, Martin E. P. (2004). "Can happiness be taught?" *Daedalus*. **133** (2): 80–87. doi:10.1162/001152604323049424. JSTOR 20027916.

Selye, Hans (1975). "Implications of Stress Concept." *New York State Journal of Medicine*. **75**: 2139–2145.

Selye, Hans (1983). "The Stress Concept: Past, Present and Future." In Cooper, C. L. *Stress Research Issues for the Eighties*. New York, NY: John Wiley & Sons. pp. 1–20.

Selye, Hans (1974). *Stress without distress*. Philadelphia: J.B. Lippincott Company. p. 171.

Shaver, P.; J. Schwartz; D Kirson; C. O'Connor (June 1987). "Emotion knowledge: further exploration of a prototype approach." *Journal of Personality and Social Psychology*. **52**(6): 1061–1086. doi:10.1037/0022-3514.52.6.1061. PMID 3598857.

Sherwood, Lauralee (2011). *Fundamentals of Human Physiology* (4th ed.). Belmont, CA: Brooks/Cole Cengage Learning. p. 91. ISBN 978-0-8400-6225-3

Sherlyn Jimenez (2011) see article on Compassion, *The Encyclopedia of Positive Psychology*, Volume I, Editor: Shane Lopez, Wiley-Blackwell, ISBN 978-1-4051-6125-1.
https://books.google.co.th/books?id=ntxUuBtSwzsC&pg=PT213&lpg=PT213&dq=Jimenez+compassion&source=bl&ots=FmQpHgRJ4x&sig=ACfU3U3_pW57LkI74_1DwPdme0zWdexmug&hl=th&sa=X&ved=2ahUKEwiIhoTkq73hAhV-6XMBHRTuCrcQ6AEwBXoECAYQAQ#v=onepage&q=Jimenez%20compassion&f=false

Schlesinger, Arthur M. (1964). "The Lost Meaning of 'The Pursuit of Happiness.'" *The William and Mary Quarterly*. **21** (3): 325–27. doi:10.2307/1918449. JSTOR 1918449.

Smart, J.J.C. (1956). "Sensations and Brain Processes. *Philosophical Review.*

Smart, J.J.C. (2011). "The Mind/Brain Identity Theory," *The Stanford Encyclopedia of Philosophy* (Fall 2011 Edition), Edward N. Zalta (ed.).

Smith, Tiffany Watt (2016-06-07). *The Book of Human Emotions: From Ambiguphobia to Umpty -- 154 Words from Around the World for How We Feel*. Little, Brown. ISBN 9780316265393.

Spencer, F. Scott (2017). *Mixed Feelings and Vexed Passions: Exploring Emotions in Biblical Literature*. Atlanta, GA: SBL Press. p. 61. ISBN 9780884142577.

Spinoza, Baruch (1670). *Tractatus Theologico-Politicus (A Theologico-Political Treati).*

Stargardt, Janice. "Tracing Thoughts Through Things: The Oldest Pali Texts and the Early Buddhist Archaeology of India and Burma." *Royal Netherlands Academy of Arts and Sciences*, 2000, page 25.

Staudinger, U.M.; Lopez, D.F; Baltes, P.B. (1997). "The psychometric location of wisdom-related performance: Intelligence, personality, and more?" *Personality and Social Psychology Bulletin*. **23**(11): 1200–1214. doi:10.1177/01461672972311007.

Staudinger, U.M.; Glück, J. (2011). "Psychological wisdom research: Commonalities and differences in a growing field." *Annual Review of Psychology*. **62**: 215–241. doi:10.1146/annurev.psych.121208.131659. PMID 20822439.

Sternberg, R. J. (1985). "Implicit theories of intelligence, creativity, and wisdom." *Journal of Personality and Social Psychology*, **49**, 607–62.

Stuart Sutherland (1989). "Consciousness." *Macmillan Dictionary of Psychology*. Macmillan. ISBN 978-0-333-38829-7.

Susan Schneider and Max Velmans (2008). "Introduction." In Max Velmans, Susan Schneider. *The Blackwell Companion to Consciousness*. Wiley. ISBN 978-0-470-75145-9.

Sytsma, Justin and Machery, Edouard (2010). "Two conceptions of subjective experience." *Philosophical Studies*. **151** (2): 299–327. doi:10.1007/s11098-009-9439-x. http://philsci-rchive.pitt.edu/4888/1/Two_Conceptions_of_Subjective_Experience.pdf

Taylor, M.; Bates, G.; Webster, J.D. (2011). "Comparing the psychometric properties of two measures of wisdom: Predicting forgiveness and psychological well-being with the Self-Assessed Wisdom Scale (SAWS) and the Three-Dimensional Wisdom Scale (3D-WS)." *Experimental Aging Research*. **37**(2): 129–141.
doi:10.1080/0361073X.2011.554508. PMID 21424954.

Teo, Loo Yee; Fam, Jia Yuin (2018). "Prevalence and determinants of perceived stress among undergraduate students in a Malaysian University." *Journal of Health and Translational Medicine*. **21** (1): 1–5.

Thomas Hobbes (1904). *Leviathan: or, The Matter, Forme & Power of a Commonwealth, Ecclesiasticall and Civill*. University Press. p. 39.

Tokumitsu, Miya (June 2017). "Did the Fun Work?" *The Baffler*. 35.

Trnka R., Lorencova R. (2016). Section on consciousness on pp. 33–42 in *Quantum anthropology: Man, cultures, and groups in a quantum perspective*. Prague: Charles University Karolinum Press. ISBN 978-80-246-3470-8.

Ussher, J. and Elrington, C. R. (1613). *The whole works*, Volume 2. Hodges and Smith. p. 417.

Walsh R. (June 2015). "What is wisdom? Cross-cultural and cross-disciplinary syntheses." *Review of General Psychology*. **19**(3): 178–293.
doi:10.1037/gpr0000045.

Winnicott,D.W. (1973). *The Child, the Family, and the Outside World*. (Penguin 1973) p. 239.

Whishaw, Bryan Kolb, Ian Q. (2010). *An Introduction to Brain and Behavior* (3rd ed.). New York: Worth Publishers. p. 72. ISBN 978-0-7167-7691-8

พระไตรปิฎกเล่มที่ ๑๑ พระสุตตันตปิฎกเล่มที่ ๓ [ฉบับมหาจุฬาฯ] ทีฆนิกาย ปาฏิกวรรค
http://www.84000.org/tipitaka/attha/m_siri.php?B=11&siri=10

พระไตรปิฎกเล่มที่ ๑๙ พระสุตตันตปิฎกเล่มที่ ๑๑ [ฉบับมหาจุฬาฯ] สังยุตตนิกาย มหาวารวรรค, วิภังคสูตร
http://www.84000.org/tipitaka/read/m_siri.php?B=19&siri=8

APENDIX 1

Mental faculties: 52 elements

Neutral Effect		Unhealthy Effect				Healthy Effect			
Universal	Occasional	Universal	Occasional			Universal	Occasional		
-	-	-	Greed	Hate	Other	-	Abstinence	Infinity	Wisdom
1* 2 3 4 5 6 7	8 9 10 11 12 13	14 15 16 17	18 19 20	21 22 23 24	25 26 27	28 29 30 31 32 34 35, 36 37, 38 30, 40 41, 42 43, 44 45, 46	47 48 49	50 51	52

I. Mental state with neutral effects

A. Universal or general occurrence of mental states with neutral effects

1. Contact (Phassa)
2. Feeling (Vedana)
3. Perception (Sanya)
4. Intention (Chetana)
5. One-pointedness (mental unity) (Ekaggata)
6. Life faculty (Jivitindriya)
7. Attention (Manasikara)

B. Occasional or specific occurrence of mental states with neutral effects

8. Initial thought (Vitakka)
9. Sustained thought (Vichara)
10. Determination (Adhimakkha)
11. Energy (Viriya)
12. Rapture (Piti)
13. Wish (Chanda)

II. Mental state with negative effects

A. Universal or general occurrence of mental states with negative effects

14. Delusion (Moha)
15. Shamelessness (Ahirika)
16. Moral fearlessness (Anottappa)
17. Restlessness (Uddhacca)

B. Occasional or specific occurrence of mental states with negative effects

18. Greed (Lobha)
19. Wrong view (Ditthi)
20. Conceit (Hoha)

21. Hatred	(Dosa)
22. Envy	(Issa)
23. Stinginess	(Macchariya)
24. Worry, remorse	(Kukkucca)
25. Sloth, laziness	(Thina)
26. Torpor, tiredness	(Middha)
27. Skepticism, doubt	(Vicikicca)

III. Mental state with positive effects

A. Universal or general occurrence of mental states with positive effects

28. Confidence	(Saddha)
29. Mindfulness	(Sati)
30. Moral shame	(Hiri)
31. Moral fear	(Ottapa)
32. Non-greed	(Alobha)
33. Non-hatred	(Ashosa)
34. Equanimity	(Tatramajjattata)
35. Tranquility of mental factor	(Kayapassaddhi)
36. Tranquility of consciousness	(Chittapassaddhii)
37. Lightness of mental factor	(Kayalahuta)
38. Lightness of consciousness	(Chittalahuta)
39. Pliancy of mental factor	(Kayamuddhuta)
40. Pliancy of consciousness	(Chittamuddhuta)
41. Adaptability of mental factors	(Kayakammanyata)
42. Adaptability of consciousness	(Chittakammayata)
43. Proficiency of mental faculty	(Kayapakanyata)
44. Proficiency of consciousness	(Chittapaganyata)
45. Proficiency of mental factor	(Kayyujukata)
46. Rectitude of consciousness	(Chittujukata)

B. Occasional or specific occurrence of mental states with positive effects

(i) Abstinence

47. Right speech	(samma vaca)
48. Right action	(Samma kamanta)
49. Right livelihood	(Samma ajiva)

(ii) Infinite

50. Compassion	(Compassion)
51. Sympathetic joy	(Mudhita)

(iii) Wisdom

52. Wisdom	(Panya)

International Journal of Research & Methodology in Social Science
Vol. 5, No. 1, p.53 (Jan. – Mar. 2019). ISSN 2415-0371 (online)
www.socialsciencepublication.com; DOI: 10.5281/zenodo.2667563

Fundamentals of a New Research Method

Dante Roberto Salatino★

About the author

★Dante Roberto Salatino is a researcher of the Institute of Philosophy and of the Institute of Linguistics - Lecturer in the General Psychology Department – Lecturer in the Philosophical Aspects of Physical-Mathematical Science Department - Faculty of Philosophy and Letters - Teacher and Researcher in Artificial Intelligence in the Mechatronics Career - Faculty of Engineering - National University of Cuyo - Email for correspondence: dantesalatino@gmail.com

ABSTRACT

The objective of this work is to give a foundation, as an auxiliary or complementary research method, to the search for an adequate explanation of real phenomena or not, elaborated from the perspective of the observer. There are several antecedents from philosophy and from science, which justify this way of analyzing the biological, psychic and sociocultural reality of man. By using the same tool, we are approached the scientific method and explananed the structure of theory and research models. We use transcurssive logic, as we call the method we have developed, to characterize a "semantic-relational transform." That is, as the temporal evolution of a relational structure allowing the delimitation of the fundamental elements that intervene any original approach made of the real dynamics. Then, in the case of scientific problems, it can be applied to them; the rigorous process of analysis, organization of available material, ordering, and criticism of the ideas required by the current methodology so that what is obtained is valid scientific knowledge. In this way, guidelines are given to favor both creativity and discovery, by simultaneously opposing the observer to the observed, through quantitative and qualitative transformations. Numerous examples of successful application are provided in different areas of human knowledge. From all of the above arise the methodological foundations that are summarized as: a) Find the fundamental elements that characterize a phenomenon. b) Depending on a pair of conflicting attributions, assign them an operative identity; c) With the fundamental elements and the transformations that link them, form an algebraic group of permutation, which acts as a "basic dynamic pattern" while at the same time ensuring the appropriate methodological adjustment, and d) Any transformation that does not belong to the "basic pattern" can be used to transfer to a new system, representative of another phenomenon, the fundamental aspects of known systems so that once they conform to the generic pattern, we can explain the new phenomenon.

Keyword: scientific theory and explanation, scientific method, methodological foundation, creativity, transcurssive logic.

CITATION:

Salatino, D. R. (2019). “Fundamentals of a new research method” *Inter. J. Res. Methodol. Soc. Sci.*, Vol., 5, No. 1: pp. 52-73. (Jan. – Mar. 2019); ISSN: 2415-0371.

International Journal of Research & Methodology in Social Science
Vol. 5, No. 1, p.54 (Jan. – Mar. 2019). ISSN 2415-0371 (online)
www.socialsciencepublication.com; DOI: 10.5281/zenodo.2667563

1.0 INTRODUCTION

On the banks of the Rhine, a beautiful castle had been standing for centuries. In the cellar of the castle, an intricate network of webbing had been constructed by industrious spiders who lived there. One day a strong wind sprang up and destroyed the web. Frantically the spiders worked to repair the damage. They thought it was their webbing that was holding up the castle.
Morris Kline, 1980, p. 277.

Philosophy and Science, as diverse branches of knowledge, harbor a logic that sustains them and gives the possibility that the first justifies the second. However, this is not the only coincidence or relationship since both in addition to trying to found a set of statements about reality, constitute a method.

The methodological value provided by both philosophy and science is multifaceted. Basing an argument to reach the truth is proper to philosophize. While to elaborate a hypothesis on a real phenomenon, in order to look for an element with what to measure and to elaborate an experiment that allows corroborating the hypothesis, it is in itself a scientific task. Despite the apparent methodological differences, both pursue a common goal to explain the facts.

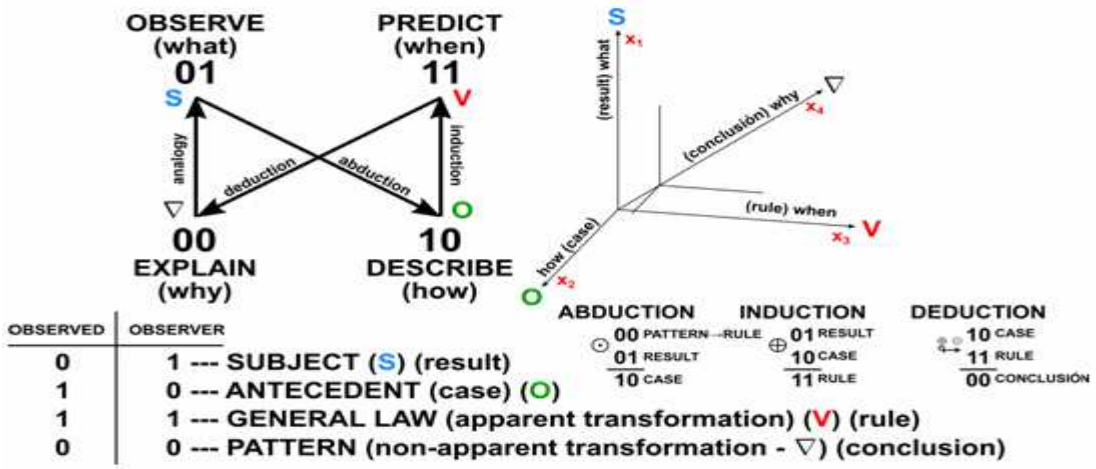
The nature of this explanation, although it is show in different ways according to the perspective from which it is analyzed, actually obeys a composition of similar basic elements. In this paper, we will try to base a useful methodology to approach the investigation of real phenomena, in search of an adequate explanation of them, elaborated from the perspective of the observer.

2.0 EXPLANATION

Explanation is not so much to clear the facts of what prevents us from understanding, as an attempt to make them compatible with the beliefs, principles, and convictions that make up our knowledge. Given that reality manifests itself to us as a continuous, indefinable and persistent process, explaining its facts will require making at least some of its fundamental aspects ostensible. Following the proposal by Aristotle (2007, Book II, Chapter 3 - The causes) we will start from the mere apprehension of the "what" to reach the first cause, to true knowledge, to an explanation of "why" the phenomenon is analyzed.

We could assimilate a real phenomenon, by using a day-to-day frame of reference to the Cartesian system that we use to represent space. In its three dimensions, we will have three basic aspects that will allow us to characterize any phenomenon: "what" makes it manifest, "how" it does it and "when" it occurs.

Fig. 1. Explanation of a phenomenon



To achieve our goal, we will turn to the argumentative options of the basic modes of reasoning provided by Philosophy (Aristotle, 2004), Logic (Peirce, 1878) and Science (Samaja, 2005). On the other hand, we will take with a certain license and as a guide, the nomological-deductive model of Carl G. Hempel (1965).

In Figure 1, we see a subject (S = 1D) observing the "what" of any phenomenon (1D). This observation is not made impartially but is conditioned by a "pattern" (Samaja, 2005, p.106) taken by analogy, as an "implicit universal individual" (Hegel, 1982, T.II, p. 392). This way of "observing" will allow the observer, to extract from the "analogous rule" (known), the rule of the analogate (unknown) phenomenon. The "analogous rule" does not derive from observation itself, but from praxis. By an abductive mechanism (rule (pattern) + result → case), which contributes on existence and actuality, we can achieve the "how", that is, describe the observed phenomenon, thus obtaining the antecedent event demanded by the nomological-deductive model, as its explanandum or object (O = 2D) of the observation (Hempel, 1965, p.246).

An inductive mechanism (result + case → rule) that tells us about generality allows us to predict the phenomenon ("when"). That is, to assign a general law, which is none other than the one provided by the "pattern", and so, based on experience (in a habit or custom) (Hume, 1894, p.44) to expect in the future a succession of events similar to those that appeared in the past, in similar situations. We have reached the third dimension (3D) that characterizes our phenomenon, or the "general law" that in appearance, directly relates the observer subject and the observed object (V = 3D).

Finally, a deductive mechanism (case + rule → conclusion) that promotes possibility and potentiality allows us to arrive at an explanation of the phenomenon that we are analyzing. The explanation obtained is independent of both the observer and the observed phenomenon, that is why it is "dimensionless" (∇ = 0D). One's "absence" in the Cartesian system, in reality, tells us that it is projected in a fourth dimension (4D = coordinate axis inscribed in the figure). It represents an indirect (or qualitative) relationship between the observer and the observed, so it is impossible to detect it.

3.0 UNIVERSAL PATTERN

In the previous point, we have verified that it is possible to move from the "what" to the Aristotelian "why" of a phenomenon, taking as a guide a pattern that provides the general law from which, by deduction, arise a conclusion, an explanation or the cause (s) determinant (s) of the phenomenon that we are analyzing. This was possible by integrating inductive and deductive reasoning with reasoning by analogy (abduction). Such an elaboration would cease to be pure conjecture if we were able to find as a pattern an "implicit universal individual," inductively providing a general law based on a "sample" that encompasses the entire universe (ideal induction). In this way, it is possible to avoid the criteria of the critical approach that Hempel makes about induction, in his logical theory of confirmation (Hempel, 1965, p.5)

Thus, we propose a complementary research method. The main foundation of this proposal lies in having discovered that the interrelationships maintained between the fundamental aspects that define any phenomenon (real or not), constitute a "universal pattern" based on a group of transformations. An invariant that respects the principle of symmetry and, therefore, adheres to the principle of "uniformity of nature" elaborated by J. S. Mill (1882, p.400), as the foundation of induction. Principle confirmed by Emmy Noether (1915-1918) when he demonstrated the conservation of natural laws over time, by relating in his theorem, the symmetry of a system with quantities that are conserved.

The first outline of a possible universal pattern emerges when reading the "Poetics" of Aristotle.

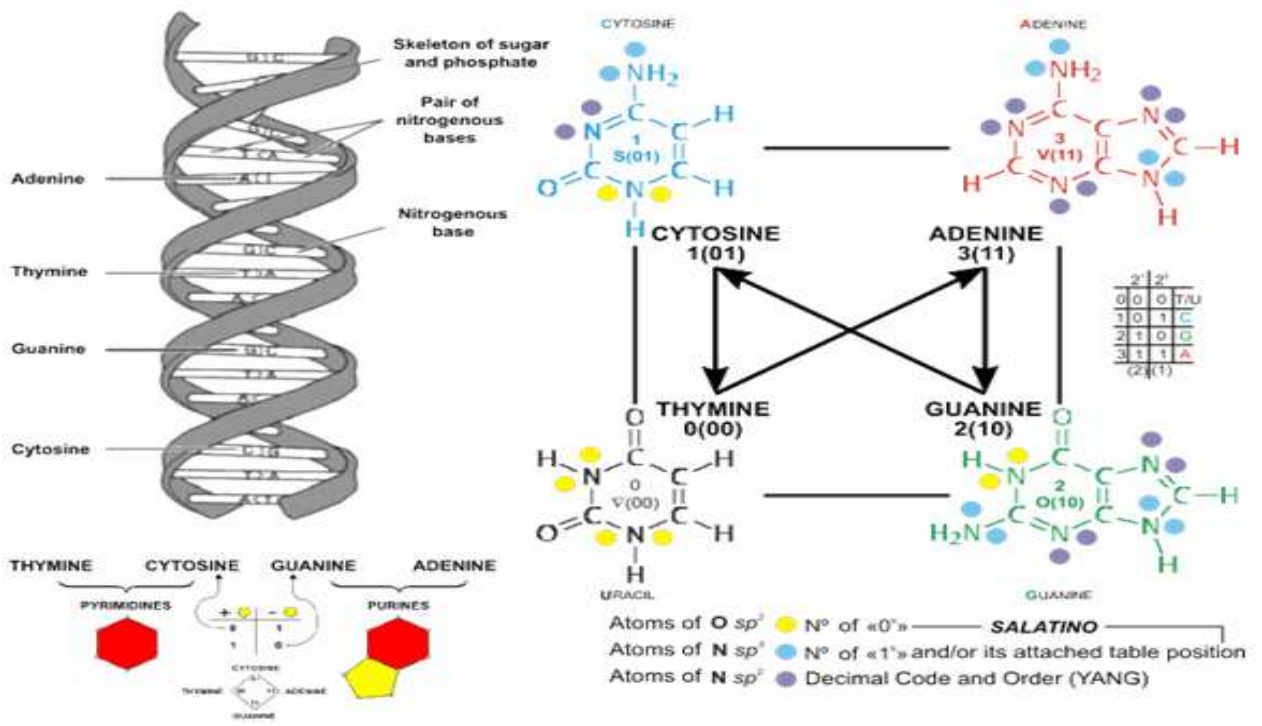
> "I explain the metaphor by analogy as what can happen when, of four things, the second remains in the same relation to the first as the fourth to the third; then you can talk about

the fourth instead of the second, and the second instead of the fourth." (Aristotle, 2011, Chapter XXI, 1457b).

In symbols, it would be **2 : 1 :: 4 : 3**. That is, the second is to the first as the fourth is to the third. This, in addition to expressing two oppositions by complementarity, represents the germ of all Aristotelian logic.

It is curious, but the DNA molecule, the basis of the genetic code and life, turned out to be structured in the same way. Figure 2 shows the arrangement of its nitrogenous bases (cytosine, guanine, adenine, thymine) in opposite pairs. Both the decimal codes (which give their order or "relational valence") and the binary codes (which identify the pairs of opposite and complementary bases) assigned, have a solid foundation. The former is based on their electrochemical structure (number of nitrogen atoms with sp2 hybrid orbitals). While the seconds depend on the chemical structure (presence or absence of different heterocyclic rings).

Fig. 2 DNA Molecule (Salatino, 2009)



The assignment of binary codes to the basic components of the DNA molecule allowed us to demonstrate that this composition of abstract elements conforms, structurally, a permutation group or Galois group. From the functional point of view it also represents a "connection" of Galois, that is, the opposition of two aspects through another opposition.

"Different interests that lead to different procedures can gather evidence that can then materialize in an empirically grounded worldview." (Feyerabend, 2001, p.184)

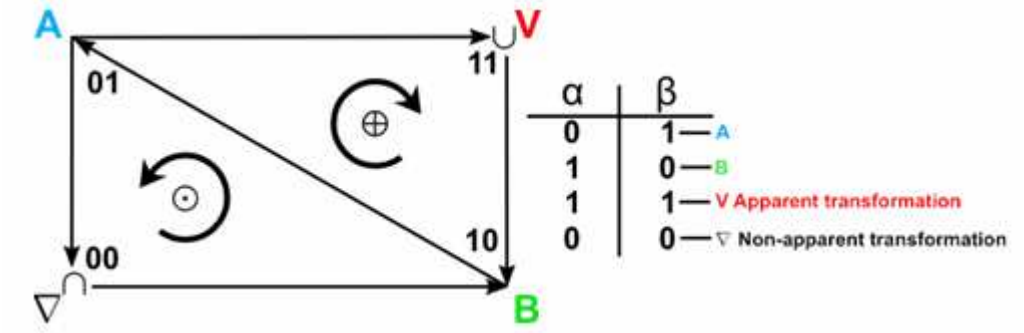
The aphorism of Van Fraassen (1989) "Similar problems have similar solutions", and the fact that DNA is a "universal pattern", a series of practical examples were taken to demonstrate the relevance of the method of searching for a basic relational pattern as part of the solution of a given problem.

4.0 GENERIC GROUP

To address the different approaches, to which we should find a solution or an explanation, a tool based on a generic Galois group was built.

Isolating the essential or relevant structure of a phenomenon is equivalent to defining a group of transformations that, once applied, leave the problem, essentially, in the same situation from where it started (invariance). These transformations are the "symmetries" of the problem (Noether, 1918) With the essential aspects formed a group (a logical-structural arrangement) which we call PAU (Universal Autonomous Pattern), and the solution consists of a rule (a function) that depends only on those basic parameters (Figure 3).

Fig. 3. Generic Group



In the previous figure we see two essential aspects of any phenomenon (A and B) and the relationships that they keep with each other through two transformations: a superficial or apparent (V) and another hidden or profound (∇). The way we have to identify each of these elements is through the individualization of some characteristic that is specific to each essential aspect (α and β). According to the resulting binary codes, A is identified as having the characteristic β, but not the α. On the contrary, B is identified as having the characteristic α, but not the β. This is telling us that A and B are opposites concerning the characteristics α and β, which are mutually exclusive. The transformations are distinguished because, the superficial (V) has both characteristics (α and β) of the aspects it relates (A and B), is what we call co-presence or organization, or what is evidenced in any phenomenon that is being observed.

The profound transformation (∇), on the other hand, shows a total absence of the characteristics that identify the aspects it relates (co-absence or disorganization). As we can see, as with the essential aspects (A and B), here the transformations V and ∇ are opposite. Both pairs are also complementary, since added give the apparent unit (11), which is nothing but the evident or superficial transformation (the organization). It is thus formed an opposition mediated by another opposition (Galois connection).

In the scheme of the figure, it is observed that between A and B there exists, in addition to the direct relationship, mediated by a transformation that we have described, an indirect relation between them shared by the two cycles that have been formed. A superficial one dextro-rotated (in the clockwise direction) that represents the symmetries of rotation of the system and constitutes the "objective or quantitative pole", and a deep one of left-handed rotation (in the anti-clockwise direction) as an evidence of reflection symmetries of our universal pattern and represents the 'subjective or qualitative pole'. The opposite turns are another way of complementarity that ensures the simultaneity in the operation of both cycles, where both the quantitative and the qualitative aspects of any real phenomenon or not must be present at the same time (heterarchy).

Finally, so that the whole system is not just an inert structure, there must be a rule or function that sets it in motion. This rule (⊕ = XOR) allows to 'move' superficially, to the right (quantitative or apparent transformation) each of the elements of the level to take the place of its successor in the sequence, without losing
its own identity (symmetry of rotation), until the system returns to the beginning from where it started. With the previous operation, we assume that we have reached the solution of the problem

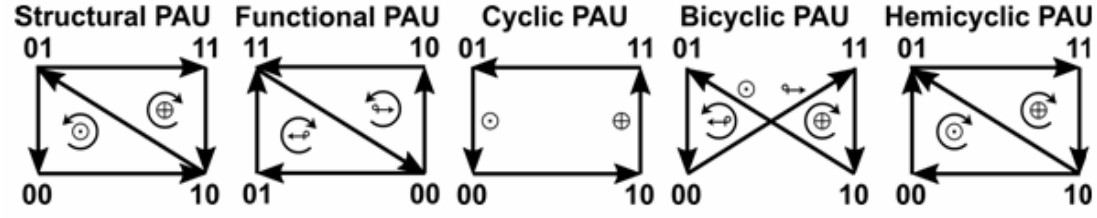
posed by the observable aspects of the phenomenon. At a deeper level, and as it could not be otherwise, the rule or function used is the opposite of the superficial one (⊙ = XNOR or equivalence), which allows elements of the system to be moved to the left. Here, when the system returns to the original disposition, after the successive qualitative transformations, we obtain the complete solution to the problem (reflection symmetry). In short, it is this level, that aspects that characterize a phenomenon, the determinant of what the same phenomenon, shows us in appearance. What unites the two levels is the experience that arises from having solved, sometimes, a similar problem.

The relational structure that we have used meets the characteristics that identify a permutation or Galois group. 1) Closure: the application of a composition transformation (XOR) to a pair of its evident elements produces another element that belongs to the set. 2) It has a neutral or identity element (00) such that composed with any other element it does not modify it; 3) Each element of the set has its inverse, such that composed by a transformation, they give the neutral element. 4) Associative property: all the compositions achieved through a certain transformation are independent of their grouping. 5) The closing of the conjugate: there is an opposite transformation to the composition (XNOR) that, applied to the non-evident elements, produces another element of the set.

5.0 PAUs LIBRARY

To face the analysis of a great diversity of phenomena, which we consider as if they were systems, we have several types of PAUs. These relational structures are always shaped by the same generic and fundamental elements, only varies in each type, the sequence of their relationships (Figure 4).

Fig. 4. PAUS Library



5.1 Structural PAU

This relational disposition is useful when we must analyze a system (composed of subsystems) that interacts with its immediate environment. Here, the function of the system depends, exclusively, on its relational structure. It handles the dynamics
generated by only two variables (opposite and complementary) and does so through basic binary operations (XOR (⊕) and XNOR (⊙)). Application examples: Neurophysiology (Neuronal and cerebral functioning), Psychology (Psychic time, Psychic structure and function, Psychoanalytic theory, Subjective reality), Organic Chemistry (Bistable systems, DNA), Medicine (Immunology of pregnancy), Logic (Laws of equivalence , Dialogics), Mathematics (Theory of groups, Differential equations, Fundamental theorem of algebra, Statistics), Physics (Electromagnetism, Theory of relativity, Quantum physics, Particle physics, Automatic control, Electrical circuits), Art (Literature (tales of Borges), Painting (Escher's work), Music (language and musical composition), Creativity), Biology (Genetic code, Formation of the organs of flowers), Linguistics (Acquisition, understanding and production of natural language), Astronomy (Copernican Revolution), Economics (Quality control), Philosophy (Epistemology), Science (Scientific research, Methodology of research), etc. (Salatino, 2009, 2012, 2013, 2015, 2016, 2017, 2018).

5.2 Functional PAU

It allows address systems that represent an assembly of two or more structures to alternate in their functions. It can handle two or more variables through hybrid binary operations (↞ (⊙⊕) / ↠

(⊕⊙)). Examples: Economics (Economic theory, Game theory, Nash equilibrium), Theory of Evolution (Adaptation, natural balance, readaptation), Philosophy (Classification of sciences, On knowledge according to Plato, Scientific research), Psychology (Behavior and conduct, psychoanalytic theory) (Salatino, 2013, 2015, 2017e)

5.3 Cyclic PAU

This PAU allows the analysis of systems where its two levels (superficial and profound) show an explicit heterarchy. That is, its dynamics are activated by a single operation or by the use of both basic operations at the same time. This way of projecting the transformations causes the golden rule of this approach to be violated: "The profound level of a PAU, always cycles in the opposite direction to the superficial level." Here, the profound level is " dragged "by the superficial level, so that a single cycle is formed. Examples: Physics (Maxwell's Law, Stepper Electric Motors, Electrical Circuits), Mathematics (Statistics, Logarithms) (Salatino, 2016, 2017).

5.4 Bicyclic PAU

The use of this PAU is convenient when the system analyzed shows a behavior that could be called "oscillatory," due to the cyclic variations that its dynamics show. However, it also allows us to study systems that show hysteresis in its different modalities. Thus, it allows describing both the tendency of a material to conserve some of its properties in the absence of the stimulus that generated it, and those systems, structurally stable, that tend to manifest discontinuity (abrupt changes in behavior) or divergence (positive feedback). It is possible to analyze systems where their current state depends on their previous history, but if the behaviors are reversed, never return to the initial state. Examples: Physics (Electromagnetism, Electrical circuits, Chemistry), Philosophy (Conceptual evolution), Psychology (Behavior and conduct), Sociology (Competitive behavior, Models of organizational change, Models of social evolution), Economy (Unemployment rate), Logic (Laws of implication), etc. (Salatino, 2017, 2018).

5.5 Hemicyclic PAU

We can use a hemicyclic PAU when our objective is not to analyze separately the elements that determine, in appearance, the functioning of a system, as we do with a structural PAU, but to try to separate appearance of reality, as in a functional PAU. But unlike the functional PAU, here the phenomenon is approached from the direct relation of its fundamental elements and not from its transformations. Therefore, the separation between appearance and reality is achieved regardless of the functional alternation to which the elements considered may be subject. Examples: Science (Methodology of research), Mathematics (Concept of limit, Derivatives), Physics (Changes of state of matter), Neurobiology (Neural action potential), Psychology (Psychic functioning), etc. (Salatino, in press).

6.0 SCIENTIFIC METHOD

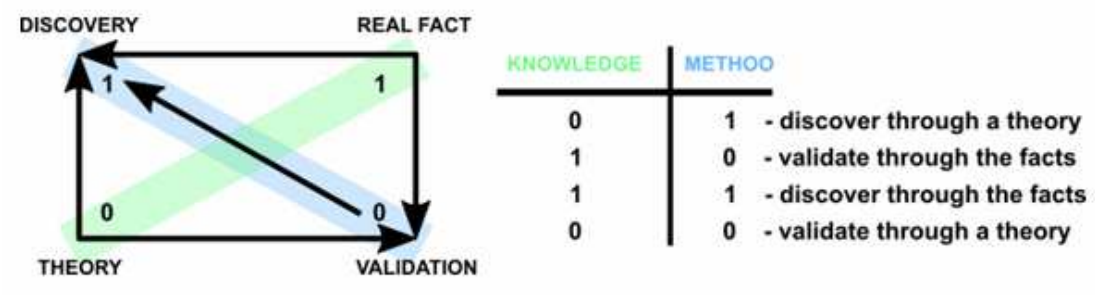
The scientific method is the main producer of knowledge in science. Based on the empirical and in the measurement, it is subject to specific rules of reasoning. (Newton, 1997, p.461)

All research is defined by an 'object of study' and by a method that enables its analysis. The 'object of study' always has to do with some portion of the reality that is intended to study, since science is, in short, a way of observing reality.

The Transcursive Logic (TL), as we call the method we have developed, also constitutes a way of scrutinizing the real, but it does so from the perspective of the subject (from the observer) and not only from the obvious or apparent manifestations that it provides us the empirical. Its 'scientific' quality is reflected in the following considerations. Scientific knowledge (the product to be achieved through research) accepts two variants: the abstract (based on theories) and the empirical (based on the facts). The scientific method, on the other hand, also admits a couple of

options: validation and discovery (Samaja, 2005, p.41). Since discovery is not comparable to facts nor validation is to a theory, it is imperative to contemplate its 'logical product.' (Figure 5)

Fig. 5. PAU of scientific research



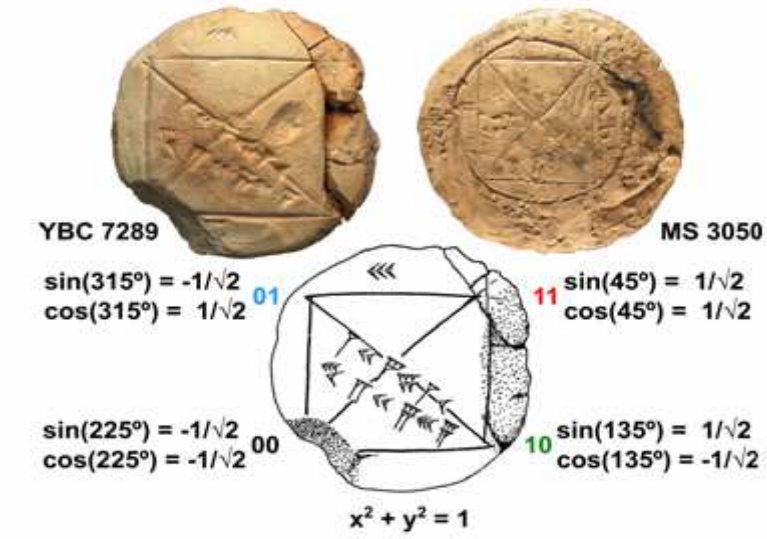
The above scheme suggests that research always consists of a combination of procedures aimed at discovering something and procedures to validate what has been discovered. Accordingly, we do not transgress the scientific norm if we used a method that adapting to the scientific knowledge we want to achieve, provide us with the necessary tools to validate what we discover (diagonal in the diagram), which would be equivalent to discovering through a theory (code 01), as occurs, for example, with theoretical physics.

7.0 ANTECEDENTS

7.1 Babylonian tablets YBC 7289 – MS 3050

The first antecedent of a relational structure similar to a PAU is found in a pair of Babylonian tablets (YBC 7289 - MS 3050) (Friberg, 2007, p 210), about 3800 years old. In the YBC 7289 tablet, with only one figure and three numbers, it shows us that the Babylonians knew that the diagonal of a square is equal to the product of the value of its side by √2. This implies that they were familiar with what we know as the Pythagorean theorem, 1200 years before the Greek mathematician was born. It also, shows that they used a sophisticated calculation method since they practiced trigonometry based on relationships, not on angles and circles. Their trigonometric tables determine two unknown reasons for a right triangle, using only a known relation.

Fig. 6. Babylon PAUs



Making use of the previous considerations, we have superimposed (Figure 6) the value of the calculation of the variables that define the diagonals of the square proposed by the Babylonians. It can be verified that they correspond to the equation x2 + y2 = 1, that is, to the Pythagorean

theorem for the case of a square inscribed in a trigonometric circle, represented in the MS 3050 tablet. If we assign '0' to the negative term (-1 / √2) and '1' to the positive term (1 / √2), we obtain the binary codes that denote the aforementioned relationships. These codes are not other than those assigned to a PAU and, therefore, meet the requirements of a group. It is easy to verify that the values housed in opposite vertices are reciprocal (opposite) and complementary, since the sum of their products, in absolute values, is worth 1:

$$(\sin(45^o) \times \cos(45^o) + \sin(225^o) \times \cos(225^o) = 1$$
$$(\sin(315^o) \times \cos(315^o) + \sin(135^o) \times \cos(135^o) = 1$$

The mathematical representations of the analyzed Babylonian tablets fulfill the requirements demanded in this work to define a PAU.

7.2 Plato

Another antecedent of our approach, we find it in the solution that Plato gives to the paradox of Zeno in the "Parmenides."

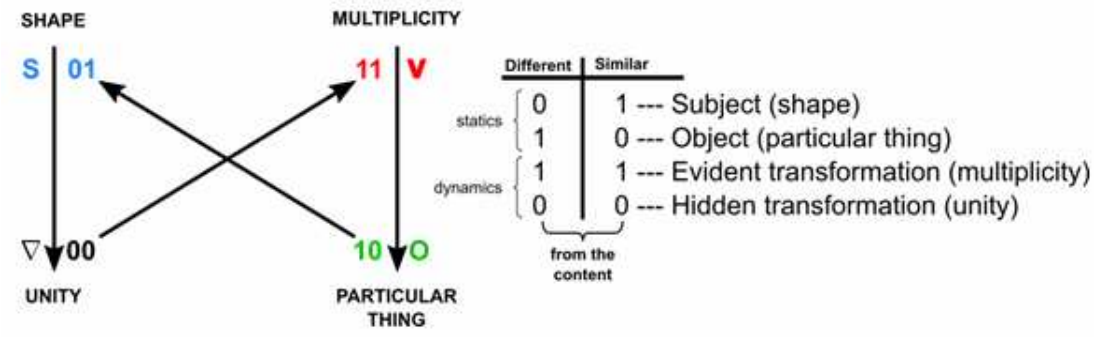
> "If there is a multiplicity, the same things must be similar and unlike. It is impossible for the like to be unlike, and for the unlike to be similar. Consequently, there is no multiplicity." (2007, 127d)

The paradox is posed as a *modus tollens*. Plato, in the words of Socrates, solves it in the following way:

> "If there are multiple things, since they are multiple, they must be different. In that sense, they are dissimilar [union]. But, since all of them are dissimilar, they have all the same affection - that of being dissimilar - and for that reason, they are similar [separation or selection]. "(2007, 130a) (the annotations between [] are own)

It can be argued that this solution is impossible. Indeed, it is impossible if it is posed from its "conceptual content," since, in this way, we cannot distinguish "thing" from "property", nor "subject" from "predicate". But it is not, from the relationship between the "continents," where the following circumstances occur:

Fig. 7. PAU paradox of Zeno



According to Figure 7, it can be admitted according to Socrates, that "a form is a unit on the multiplicity of particular things." These interrelationships, which in the static content of an apparent system (objective reality), would lead to a "return" to infinity," in a dynamic system (subjective reality) is a return to the same place, but a time later. The record of the evolution of the structure (experience, history) of a real system through time, of its elapse.

7.3 Aristotle

Aristotle in his "Physics" provides a new antecedent of this particular framing of the real. We must bear in mind that in the Greek tradition, the word "*physiké*" did not call a special science like Galileo's, but rather it designated everything that exists in the universe: the cosmos, inert matter and living matter, represented by plants, animals, and man. From this conception, the *phýsis* becomes the great protagonist of the passing of the real, of what is and happens, and will have as a thematic target, the movement [the transformation] (De Echandía, 2007, p.9). Thus seen, Physics will be the analysis of the physical according to its empirical manifestations, and as the foundation of appearances, as well as its explanatory argument. This approach is superior to the Parmenidean duality " appearance/truth", in that it considers the diversity of sensible movements as manifestations of the nature of things ("Physics", 191a25).

The Aristotelian conception of the *phýsis*, in some way, is a platonization of the legacy of the Ionians by accepting a "real fundamental nucleus" [the deep level of the qualitative], but also admits, which makes things end up being which are, its *Eidos*, that is, its external or apparent aspect [the superficial level of the quantitative]. Thus, the form ends up being what internally configures, things and the knowledge of the *phýsis*, according to its unmistakable empirical manifestations, which makes things "express." Both aspects allow understanding the Aristotelian theory of movement. The movement, as an empirical fact, is presented according to its sensible appearances, leaving a record of its passing. Consequently, the theory must start from the experience [history of the system] and build its "sense," its knowledge, so that it agrees with the observed facts ("About the sky", 306a6).

In the Aristotelian observations, we find a high degree of coincidence with what is proposed by the Transcurssive Logic (TL). In them, the fundamental elements used by the TL are displayed to define the observed reality and to try to explain its operation. Perhaps, the most important thing is to consider the "passing," as the "wadi" to follow to couple the group of transformations that demarcate the structural evolution of a system and build its history.

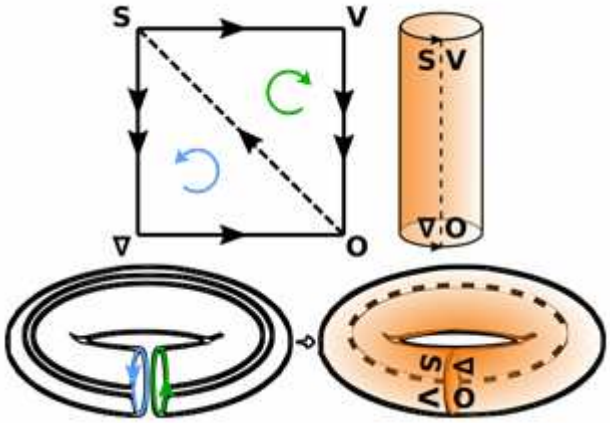
7.4 Felix Klein

A closer antecedent is Klein's work on groups of transformations applied to the Erlangen program and non-Euclidean geometry. To unify the geometric investigations, it was decided to determine what they have in common and in what different branches of Geometry they differ, taking as the only parameter, the familiar notion of space.

To achieve the above, the notion of "group of transformations of space" is invoked. This notion is based on the fact that the composition of any number of transformations of space always produces another transformation. A group of transformations is constituted when the set has the property that any transformation resulting from the composition of a pair of them also belongs to the set. There are transformations of space that do not alter at all the properties of the figures since they are independent of the position occupied in space, of its absolute magnitude and finally also of the sense in which its parts are arranged. The displacements in space, the transformations of similarities and those of symmetry do not alter the intrinsic properties of the figures. It is known as "main group" the set of all these transformations. The geometrical properties are not altered by the transformations of the "main group."

Klein, in 1882, showed that any surface could be represented by a portion of the plane using a polygon in which the points on the sides were properly identified. For demonstration, it was necessary not to take into account the distances (the content), and only to consider the identification of each side (the continent) to preserve the relations that they maintain between them. A square, for example, can be transformed into a bull, without the intrinsic properties of the figures have changed (Figure 8).

Fig. 8. Topological PAU



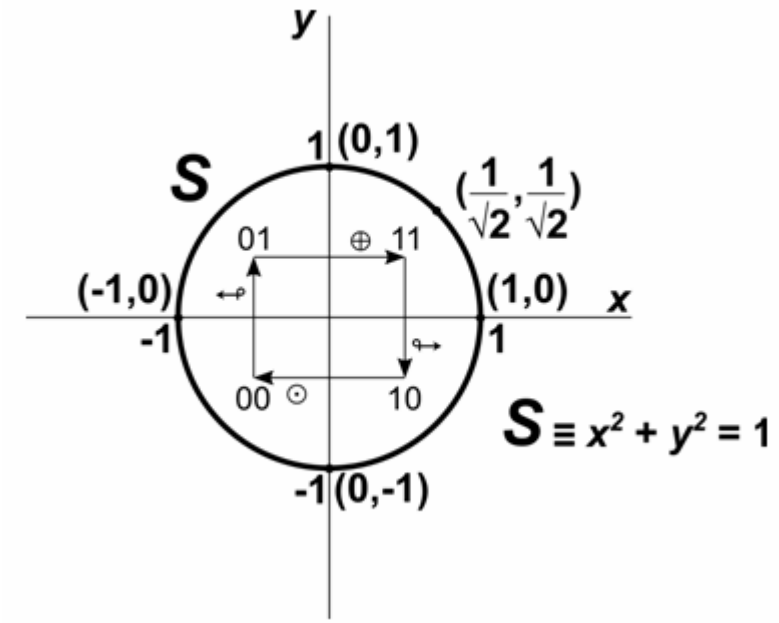
Thus, Topology emerges as a branch of Geometry, according to the Erlangen program. In effect, the topology referred to the study of the properties of surfaces that remain invariant under the action of a group of transformations (homeomorphisms). Interestingly, although Klein has not mentioned it, if we consider the points that identify the sides of the polygon (Figure 8), we see that they also form a "group", the one that identifies the fundamental elements which define the surface, and can project the transformations. That is, they form a PAU.

7.5 Emmy Noether

Inspired by the works of Hilbert and Klein, Noether through a theorem gave a solution to the elusive problem of conservation of energy in the relativistic theory. This approach ended up offering a general frame of reference that allowed us to understand the topic of the conservation of energy in physics, beyond the theory of relativity.

Emmy Noether realized that the principles of conservation of energy were related to the "groups of transformations" and to the "invariants." These last ones that were determined by her, both in the plane, as in the space, from the mathematics, imply a group of changes and something that remains fixed under the effect of those changes. This analysis of real phenomena through models reveals important properties of the phenomenon that we want to study.

Fig. 9. Algebraic PAU



Axes: -1 = 0 - ⊕: XOR - ⊙: XNOR - ↜ / ↝: hybrid

In Figure 9, if we take the values of the axes -1 = 0, binary code can be assigned to each quadrant. This code represents the solutions, in each quadrant, to the equation proposed which coincide with the circumference. Through the usual and hybrid operations, you can "rotate" for each of the solutions. The example shows the connection that exists between formulas, shapes, equations, and figures of the plane or space, using the idea of an "algebraic invariant." This allows applying certain transformations (translations and rotations) that show the correspondence of a law of symmetry and its corresponding conservation principle with energy, with angular momentum and with linear momentum.

Through a common abstract algebraic structure, which uses only the sum and the product, one can discover the intrinsic connections underlying problems, which, appear to be different. Something, the latter, which represents almost absolutely, what is proposed by this work.

7.6 Mosterín

A final antecedent of what is proposed in this research as method comes from the contributions of Jesús Mosterín (2003), in "Concepts and Theories in Science." The author tells us (p.203) that if we want to characterize the same structure projected in different systems, we need a procedure that allows us to describe that structure. This description must be independent of the systems that carry it out. This procedure - continuous - consists in the introduction of an extension of our language through the use of mathematical notions, and especially of "conceptors" (In our case, continents). A "conceptor" is a substitute, which in some way allows one to think, in innumerable different concepts (in our case, content), corresponding to the history of countless different systems. However, all these systems have something in common: a structure.

7.6.1 Theory of a structure

Mosterín shows that in any theory appear words (particle, mass, force, etc.) that do not express concepts [content], but "conceptors" [continents – Mosterín, p. 205]. On the other hand, he argues that if a system is a model of a theory, if it expresses the corresponding structure [if it is functional], then we can substitute the "conceptors" by concepts in the theorems, thus obtaining true ideas about the system in question.

Mosterín asserts that defining a structure is the same as formulating its theory. It is necessary to specify which are "conceptors" [continents] combined to make up the axioms, and what logic determines the relation of consequence between axioms and theorems. With this we would resolve mathematically, and univocally, the structure and its theory. However, this whole complex is independent of the empirical reality of the world. The latter gives foundation the subjective approach that TL makes from the observer.

8.0 EXAMPLES

To demonstrate the relevance of the approach to reality, of the statements made by science, and even of any human manifestation, from the point of view of the observer, and under the protection of a "universal standard," we will elaborate some examples.

8.1 Theoretical structure

Fig. 10. PAU of a theory

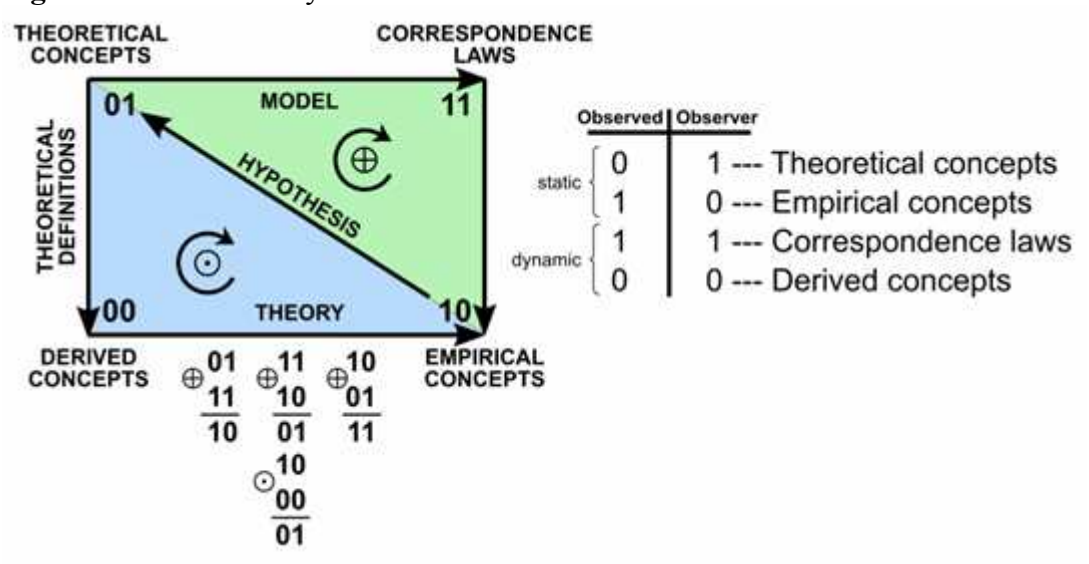


Figure 10 shows the relational pattern formed by the fundamental aspects that characterize a theory or system of concepts according to the following proposal of Hempel, analyzed from the Transcurssive Logic.

> *"A scientific theory might, therefore, be likened to a complex spatial network: Its terms are represented by the knots, while the threads connecting the latter correspond, in part, to the definitions and, in part, to the fundamental and derivative hypotheses included in the theory. The whole system floats, as it were, above the plane of observation and is anchored to it by rules of interpretation. These might be viewed as strings which are not part of the network but link certain points of the latter with specific places in the plane of observation. By virtue of those interpretive connections, the network can function as a scientific theory : From certain observational data, we may ascend, via an interpretive string, to some point in the theoretical network, thence proceed, via definitions and hypotheses, to other points, from which another interpretive string permits a descent to the plane of observation."* (Hempel, 1952, p. 36).

As shown in the diagram, there are aspects that depend on the observer (the theoretical concepts). There are some that depend on the phenomenon observed (the empirical concepts). There are "correspondence laws" that directly relate the previous two. Finally, there are aspects that relate the theoretical and the empirical in an indirect and unobservable way (the derived concepts). The binary codes correspond to the attached table of assignments and serve to identify and operate with each one of them when analyzing the dynamics of the system.

The theoretical concepts and empirical concepts related by the "laws of correspondence" elaborate a "model" that will be used to test a hypothesis (superficial or apparent level - green triangle). When the results obtained with the operation of the model do not coincide properly with the real phenomenon, that is, when the theory does not predict the phenomenon and therefore does not explain it, adjustments must be made. The way to adjust the model is to bring the theory closer to the facts. This is achieved through the derived concepts, which in a non-evident way (deep level of the system) and with a lower level of abstraction, contribute new definitions to the theoretical concepts that help verify the initial hypothesis.

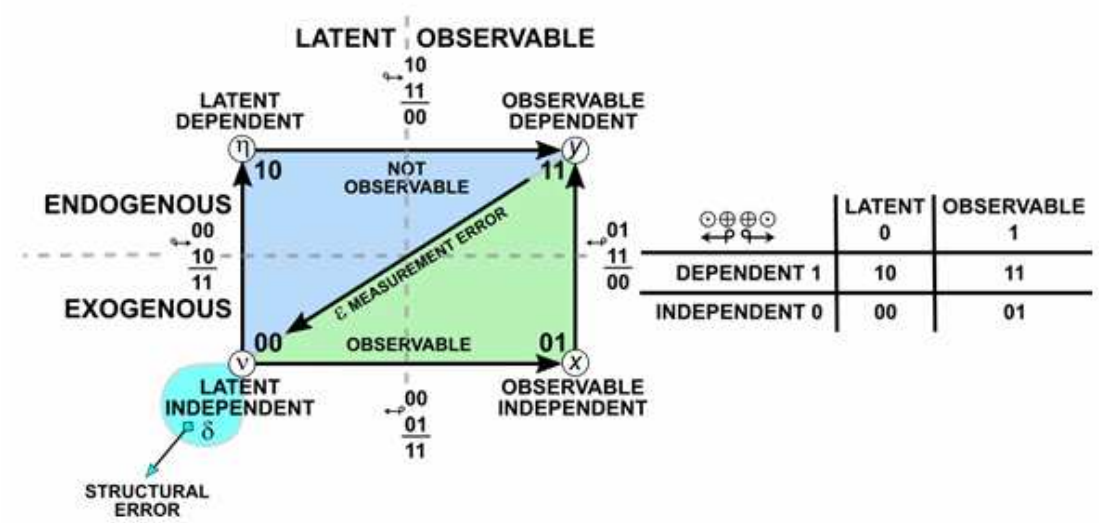
The operability of the system is demonstrated through the Boolean operations that appear at the bottom of the previous diagram. There one can see the way in which an emulation of the dynamics of the system is achieved. This dynamic consists of two cycles: one superficial (clockwise) and governed by XOR (⊕) and one deep (also clockwise) managed by XNOR (⊙) or

equivalence. The first iterates several times until adjustments are needed where the second is triggered, then back to the first.

In (TL) this relational pattern is known as hemicyclic PAU.

8.2 Research Model

Figure 11. PAU OF A RESEARCH MODEL



(Method of "trajectory analysis" or multiple regression - Wright, 1921, p 557)

As proposed by Diamantopoulos & Siguaw (2013, p.1), when we analyze any phenomenon through a model, we have to measure what is represented by two "constructs": the *observable variables* and the *latent variables* that are not observable. The *observable variables* "reflect" the *latent variables*. Therefore, they are also called "reflective indicators." In turn, both constructs can be *dependent* or *independent*. Now, if a variable is not influenced by or does not depend on any other variable in the model, it is an *exogenous variable*. The *exogenous variables* always act as *independent variables*. In the model the variable that is influenced by or depends on other variables, is known as an *endogenous variable*. It must be borne in mind that *endogenous variables* may affect other *endogenous variables*. Endogenous variables that affect others can act as *independent variables* or as *dependent variables*. Empirical measures (observable variables) never have a perfect validity and reliability, therefore, a "residual term" contemplating "inexplicable variations" must be included in the model. There are two types of error that must be considered. The *measurement error* (also known as "error in the variables") and the *structural error* (also known as "error in the equations").

In the previous scheme, all the described elements are registered, but, also, the dynamic aspects of the model are included. The sequence elaborated from the TL is the following: The non-observable sustenance of the whole system is the independent latent variable (ν) (∇ in TL) since it does not depend on or is influenced by any other model variable. The latent dependent variable (**η**) and the independent observable variable (***x***) depend on it. On the other hand, the dependent observable variable (***y***) depends on the latent dependent variable. Finally, as usual, the dependent observable variable (***y***) depends on the independent observable variable (***x***). We see that y constitutes the end of both "routes" since it represents the final result of the operation of the model and what we are going to contrast with the actual phenomenon analyzed. According to the previously mentioned relations, **ν** is doubly exogenous (00), and ***y*** is doubly endogenous (11). The table of assignments attached to the scheme completes the identification of the variables according to their respective characteristics.

Both "routes" are justified by the binary operations (hybrid ↬↫) placed on the bottom and left side of the scheme, which starts at 00 (**v**) and ends at 11 (**y**). As for the necessary adjustments for errors made in the estimates, they are recorded, the "measure," returning from the result obtained (***y***) to the "source" (**v**) carrying the corresponding correction. This is manifested by the binary operations placed on the top and right side, respectively. While, the "structural error" is nothing that can be corrected from outside the model, but from within. That is, the equations must be adjusted, those that represented by ∇, constitute the basis of the modeling.

8.3 Matter

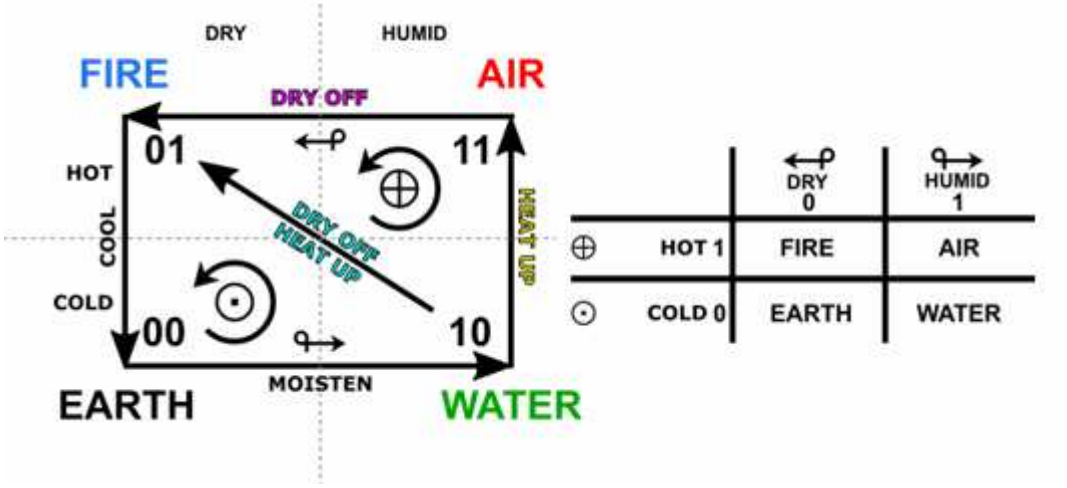
We will take as another example the concept of "matter." This concept, frankly elusive, we will approach from the proposal made by Aristotle and from particle physics, through the standard model. We do not intend with these examples to express value judgment regarding the scientific pertinence of these proposals. Rather it is an approach that will allow us to better understand each of the proposals, and also to certify that the method suggested by the TL can be applied to any area of knowledge, as something has already been proven throughout the work.

8.3.1 Aristotle

"The concept of matter is not a scientific concept, but a philosophical one" (Mosterín, 2003, p.121). Introduced in philosophy by Aristotle, today can serve to clarify, in part, the problems posed by particle physics.

Aristotle assumes that all things have as distinctive aspects a matter and a form, that is, they make up a system or set of elements (matter), provided with structure (form) (Figure 12).

Fig. 12. PAU of the fundamental components of the matter



We see in the previous diagram the dynamic relationships (the forms) that link, affecting, the fundamental elements that define the matter. The attached table of assignments justifies the binary codes that we have used to identify each element, or, rather, the "continent" of each one of them. For this, the different forms that the subject can adopt have been used.

Moving from one element to another is "simulated" by the logical operations ⊕ (XOR) and ⊙ (Equivalence), alone or combined. (↫/ ↬). These transformations suggest that the content changes, but not the continent of each element, which as we see in the table, there is one (a logical operator) for each transformation.

It is possible to follow the sequence of the PAU and to verify that, at least in the appearance and sometimes, in reality these transformations are fulfilled. Thus, if the water is heated it is transformed into the air (evaporates). If that steam dries, it turns into the fire (forest fires). If the fire cools, it becomes earth (volcanic magma). If the earth gets wet, it becomes water (alluvium). There

is a real way in which the water is transformed, directly, into the fire, by heating and simultaneous drying. This is what happens, for example, when water is heated to such a temperature that its molecular bonds break down. Water disappears as such and transforms into two gases: hydrogen (fuel) and oxygen (comburent), which produces fire.

8.3.2. Particle physics (Standard model)

In the 1940s, it was possible to determine experimentally that the atoms consisted of electron clouds (negatively charged particles) that orbit a compact nucleus located at its center. The nucleus, in turn, was made up of protons (positive charge) and neutrons (without charge). These particles arranged in a variable number determined the identity of the chemical element to which the atom belonged. But then it was learned that the elementary particles of the nucleus were composed of smaller particles (quarks). That there were subatomic particles that explained the "strong interaction" that holds protons and neutrons together inside the nucleus. In special situations like when a star collapses, it appears by disintegration (weak interaction), another group of subatomic particles. (Lederman & Hill, 2004, p.35). The process that destroys a star transforming it into Supernova, the β decay, constitutes a remarkable example of weak interaction, and it is where the following phenomenon occurs: $p^+ + e^- \rightarrow n^o + \nu^o$ (proton + electron → neutron + neutrino) (Figure 13).

Fig. 13. PAUs of the elemental forces

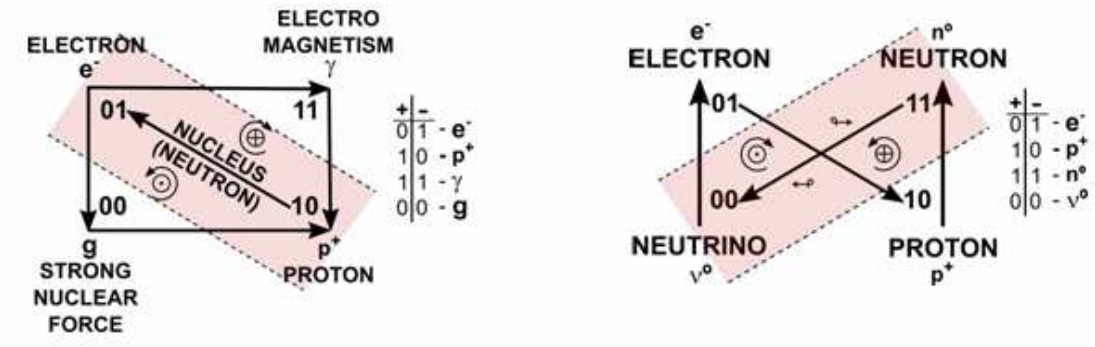
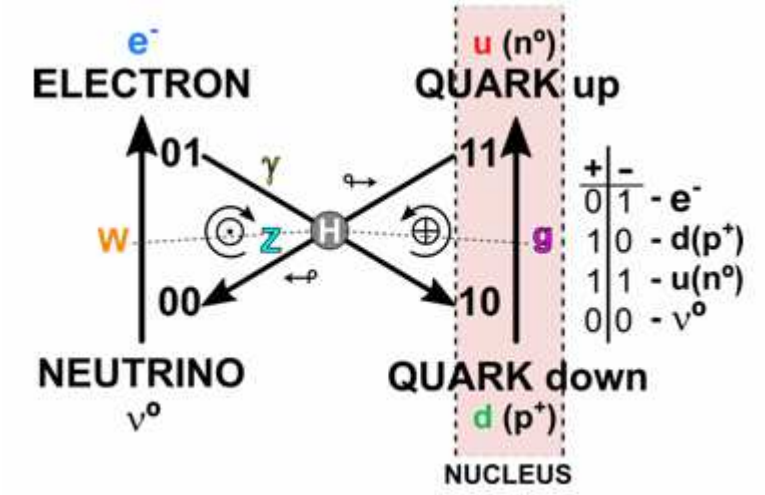


Figure 13 highlights the fundamental interactions that complete the standard particle model. These forces (equivalent to the Aristotelian forms) are (Figure 13, left): the electromagnetic that binds the electron to the nucleus and whose carrier is a boson that lacks mass and electrical charge: the photon (γ). The strong nuclear force, which links the proton and neutron within the nucleus, as well as the quarks that compose them. Its carrier is the massless boson called gluon (g). The neutrino, with no electrical charge and with very little mass, interacts with the other three particles by the weak nuclear force. (Figure 13, right) In some way, it also fits the Aristotelian intuition of matter, since, when transforming some nuclear particles in others can produce a transmutation. That is, by varying the number of protons (atomic number) that is what defines a chemical element, one can transform, for example, lead (82) into gold (79) by eliminating two protons from the nucleus of the lead atom.

From our approach, we could risk a summarized standard model, where it becomes evident that the opposing fundamental forces (forms) that affect matter arise from local processes. (Gell-Mann, 2003, p 195) (Figure 14).

Fig. 14. PAU of the standard model



References: no: neutron - p^+: proton - d (p^+): down quark of the proton - u (n^o): Quark up of the neutron ν^o: neutrino - γ: photon - g: gluon - w, z, H: bosons

In the previous figure, based on algebra, group theory and symmetry (as in the standard model of particles) we can see the interactions between the four elementary particles that constitute the "heart" of matter: e^- (electron), u (quark up), d (quark down) and ν^o (neutrino).

The intermediate bosons w and z, which are mediating particles of the weak nuclear interaction, complete the model. They are in charge, in general, to change the taste of other particles. The w-boson intervenes in the β decay in which a neutron becomes a proton and emits an e^- and an antineutrino. While the z-boson intervenes only as a carrier particle of "linear momentum." When two particles exchange a z- boson, one passes the "moment" to the other. This is called "neutral current interaction." None of the particles change the flavor. Finally, the Higgs boson (H) has a fundamental role in the mechanism that originates the mass of elementary particles.

The bosons intervene in everything we know of the universe:

γ (photon): ontogenetic life (electrochemistry)

g (gluon): phylogenetic life (sun, light, energy)

w, z (intermediate): radioactivity

H (Higgs): transform energy into mass

8.4 Lorentz group

Group theory is the language of symmetries. The Lorentz group is the group of all the Lorentz transformations of Minkowski's four-dimensional space, the classical composition of all non-gravitational physical phenomena. Here we see a simple way to represent a Lorentz group showing its composition, its transformations, and its symmetries. This group shows two symmetries, a continuous (infinitesimal) or rotation and a discrete or reflection. On the other hand, the set of all the transformations of the group is divided into four disjoint subsets, called "pieces." In turn, these "pieces" are linked by three discrete transformations: space-inversion, time-reversal, and total-inversion, so that all can derive from one of them. That is, they constitute a PAU.

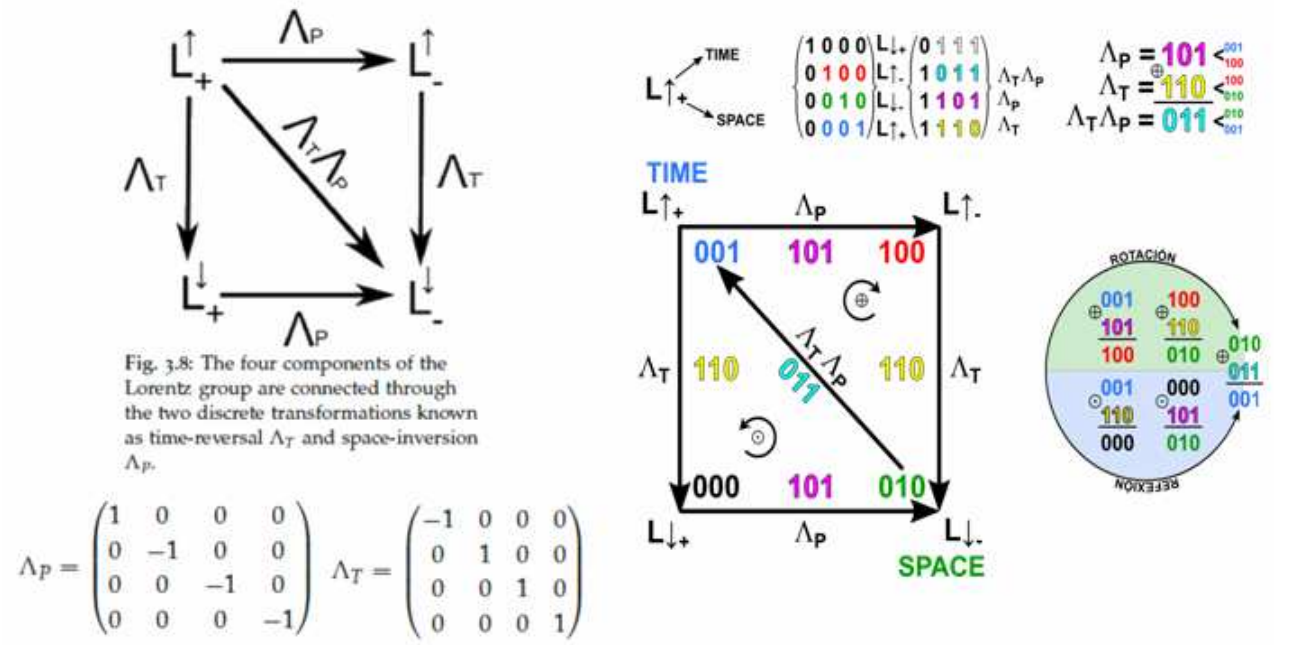


Fig. 3.8: The four components of the Lorentz group are connected through the two discrete transformations known as time-reversal Λ_T and space-inversion Λ_P.

$$\Lambda_P = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{pmatrix} \quad \Lambda_T = \begin{pmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

Schwichtenberg, J. (2018). Physics from Symmetry. Springer, p. 65.

The basic algebraic operations justify the group dynamics. That is, "arrive" from time to space by means of the two symmetries, using color codes instead of matrices.

9.0 CONCLUSIONS

Analyzing reality from the scientific point of view requires at least three levels be explored: that of the "subjective reality" or of the observer that in this work is postulated as the sustenance and determinant of the other levels, which is based on A belief." The "objective reality" is the level traditionally addressed by science and where you can choose different forms or theories from which to observe and measure the real, which is based on evidence. The "bounded reality" is explored and valued the object of study of an investigation, which is based on experience.

The 'common thread': 'belief → evidence → experience' constitutes, in turn, a PAU that assembles the fundamental elements of all research (Figure 15).

Fig. 15. General PAU of scientific research

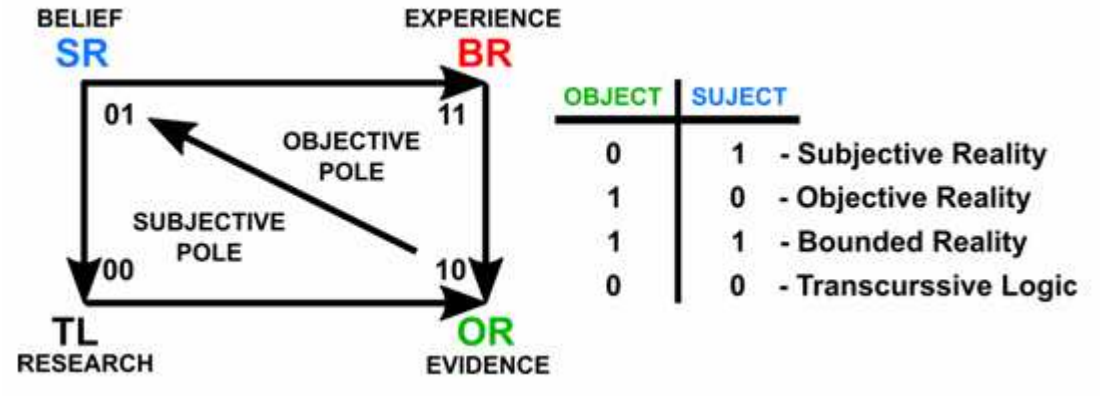


Figure 16 summarizes everything analyzed. This scheme shows the dependence between the explored levels of reality. The analysis of objective reality has been carried out from three different proposals: a) The "three worlds of knowledge" of Popper (1993); b) The levels of abstraction of Floridi (2008); and c) From the laws of symmetry of Van Fraassen (1989).

This disposition emphasizes that all research is a dynamic and evolutionary process, in which the subject who investigates and its domain constitute the main axis (∇). However, this is not an impediment for this proposal to be considered, under any aspect, as scientific.

The traditional scientific method, without being obligatory or an absolute guarantee of successful results, depends exclusively on the creative disposition to be carried out. It would be of little use as a method if it were not possible to channel this creativity. The Transcurssive Logic, which we could characterize as a "semantic-relational transformation", allows the delimitation of the fundamental elements that intervene in any original approach that is made of reality, so that, after them, the rigorous process can be applied of analysis, organization of available material, ordering and critique of the ideas required by the current methodology so that what is obtained is valid scientific knowledge.

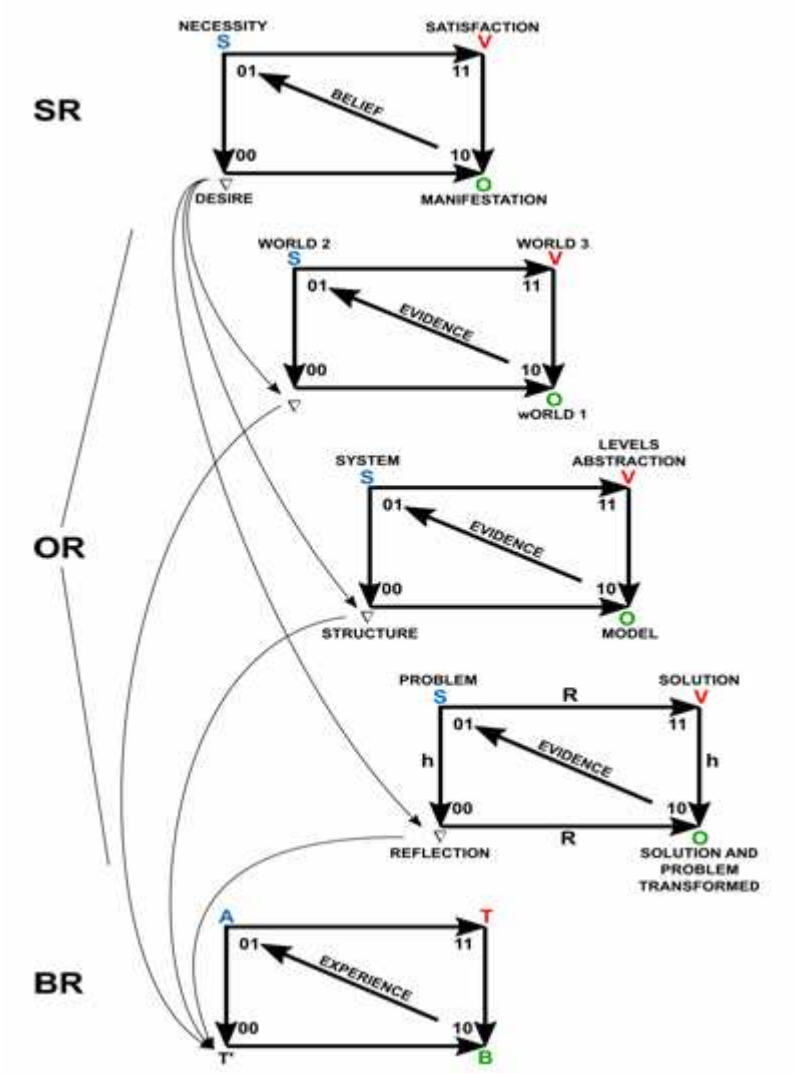


Fig. 16. PAUs of reality analysis
References: S: subject - O: object - V / T: apparent transformation
∇ / T ': not apparent transformation - SR: subjective reality
OR: objective reality - BR: bounded reality

After everything is analyzed, we can say that the interrelationships maintained between the fundamental aspects that define any phenomenon constitutes a "universal pattern" based on a group of transformations.

In this way, we established the foundations of the proposed method:

a. Find the fundamental elements that characterize a phenomenon.

b. Depending on a pair of opposing attributions, assign them an operative identity.

c. With the fundamental elements and the transformations that link them, form an "algebraic group of permutation", which acts as a "basic dynamic pattern" while ensuring adequate methodological adjustment.

d. Any transformation that does not belong to the "basic pattern" can be used to transfer to a new system, representative of another phenomenon, the fundamental aspects of known systems, so that, once they conform to the generic pattern, provide us with an explanation of the new phenomenon.

REFERENCES

Aristóteles (2004). *Tratados de lógica* (el Organón). México, Editorial Porrúa.

Aristóteles (2007). *Física*. Barcelona, Editorial Gredos.

Aristóteles (2011). *Poética*. Valentín García Yebra (Traductor). Madrid, Editorial Gredos.

Cuadrado, G. and Salatino, D.R. (2017). "Quasi-Tautologies: The Case of the Birch Moth." *Inter. J. Res. Methodol. Soc. Sci.*, Vol., 3, No. 3: pp. 53-59. (Jul. – Sep. 2017); ISSN: 2415-0371.

Diamantopoulos, A.; Siguaw, J. A. (2013). *Introducing LISREL: A guide for the Uninitiated*. London, SAGE

Feyerabend, P. (2001). *La conquista de la abundancia*. Barcelona, Paidós.

Floridi, L. (2008). "The Method of Levels of Abstraction." *Minds and Machines*, Volume 18, Issue 3, pp. 303-329.

Friberg, J. (2007). *A Remarkable Collection of Babylonian Mathematical Texts*. New York, Springer.

Gell-Mann, M.; Ne'eman, Y. (1964). *The eightfold way*. New York, W. A. Benjamin, Inc.

Gell-Mann, M. (2003). *El quark y el jaguar. Aventuras en lo simple y lo complejo*. Barcelona, Tusquets.

Hegel, G. W. F. (1982). *Ciencia de la lógica*. 2 Tomos. Buenos Aires, Ediciones Solar.

Hempel, C. G. (1952). *Fundamentals of Concept Formation in Empirical Science*. Chicago, The University of Chicago Press.

Hempel, C. G. (1965). *Scientific Explanation. Essay in the Philosophy of Science*. New York, The Free Press.

Hume, D. (1748-1894). *An Enquiry concerning the Human Understanding, and an Enquiry concerning the Principles of Morals*. Oxford, Clarendon Press.

Kline, M. (1980). *Mathematics. The Loss of Certainty*. New York, Oxford University Press.

Lederman, L. M.; Hill, C. T. (2004). *Symmetry and the beautiful universe* – New York, Prometheus Books.

Mill, J. S. (1882). *A System of Logic, Ratiocinative and Inductive: being a Connected View of the Principles of Evidence and the Methods of Scientific Investigation*. New York, Harper & Brothers, Publishers.

Newton, I. (1997 – 1687). *Principios matemáticos de la Filosofía Natural*. Buenos Aires, Ediciones Altaya S. A.

Noether, E. (1918). *Invariante Variationsprobleme*, Nachr. d. König. Gesellsch. d. Wiss.zu Göttingen, Math-phys. Klasse, s. 235-257

Masera, G.A., Vasquez, M.G., and Salatino, D. R. (2017). "The Map and the Universe: The Work of Maurits Cornelis Escher from a Cultural-Historical Approach." *Inter. J. Res. Methodol. Soc. Sci.*, Vol., 3, No. 2: pp. 27–35. (Jul. – Sep. 2017); ISSN: 2415-0371.

Peirce, C. S. (1878). "Deduction, Induction, and Hypothesis." *Popular Science Monthly*, Vol. 13, pp. 470-482.

Platón (2007). *Parménides*. Santa Cruz, M. I.; Vallejo Campos, A; Cordero, N. L. (Traductores). Barcelona, Editorial Gredos.

Popper, K. R.; Eccles, J. C. (1993). *El yo y su cerebro*. Barcelona, España, Editorial Labor, S. A.

Salatino, D. R. (2009). *Semiótica de los sistemas reales* – Tesis Doctoral en Letras especialidad Psicolingüística por la Facultad de Filosofía y Letras de la Universidad Nacional de Cuyo, Mendoza, Argentina – Director: Dra. Liliana Cubo de Severino.

Salatino, D. R. (2012). *Aspectos psico-bio-socioculturales del lenguaje natural humano. Introducción a la teoría psíquica del lenguaje* - Mendoza, Argentina - Desktop Publishing, Amazon, ISBN: 978-987-33-2379-9.

Salatino, D. R. (2013a). *Psiquis – Estructura y función* – Mendoza, Argentina – Autoedición. ISBN: 978-987-33-3808-3.

Salatino, D. R. (2013b). "El proyecto de Freíd." En: Psicoanálisis. *Revista de la Asociación Psicoanalítica Colombiana*. **24**(1-2), pp. 43-60.

Salatino, D. R. (2015a). "Ficciones, solo ficciones." En: Conceptos y Lenguajes en ciencia y tecnología. Cuadrado, G.; Redmond, J.; López, R. (Editores). *Serie: Selección de Textos*, Volumen 3, pp. 251-273. Universidad de Valparaíso, Chile. ISBN: 978-956-358-724-1.

Salatino, D. R. (2015b). *Las 2201 páginas de una teoría. La verdadera historia de la Lógica Transcursiva*. 4 Volúmenes – Mendoza, Argentina, Autoedición – ISBN: 978-987-33-6655-0.

Salatino, D. R. (2015c). "Bases neurológicas y psíquicas del lenguaje musical." En: *Actas de ECCoM, La experiencia musical: cuerpo, tiempo y sonido en el escenario de nuestra mente*. Vol. 2, Nº 1, pp. 257-267.

Salatino, D. R. (2015d). *Sobre el inconsciente* – En: Psicoanálisis – Revista de la Asociación Psicoanalítica Colombiana. Vol. XXVII, Nº 1, pp. 199-228.

Salatino, D. R. (2016a). *Procesos Cognitivos. Fundamentos Neurofisiológicos. Una teoría del funcionamiento psíquico* – Mendoza – Argentina, Autoedición – ISBN: 978-987-42-2038-7.

Salatino, D. R. (2016b). *La importancia de la simetría*. En Educación en Ciencias Empíricas en Facultades de Ingeniería. (ECEFI 2016), pp. 19-49. Ed. Cuadrado, G.; Gómez, L. – Mendoza, Argentina, Facultad Regional Mendoza –Universidad Tecnológica Nacional.

Salatino, D. R. (2017a). "Beyond the Decisions-Making: The Psychic Determinants of Conduct and Economic Behavior." *Inter. J. Res. Methodol. Soc. Sci.*, Vol., 3, No. 1: pp. 6–26. (Jan. – Mar. 2017); ISSN: 2415-0371.

Salatino, D. R. (2017b). "Beyond the Decisions-Making II: Methodological Aspects." *Inter. J. Res. Methodol. Soc. Sci.*, Vol., 3, No. 2: pp. 6–24. (Apr. – Jun. 2017); ISSN: 2415-0371.

Salatino, D. R. (2017c). *Tratado de Lógica Transcursiva. El origen evolutivo del sentido en la realidad subjetiva*. Mendoza, Argentina, Primera autoedición. ISBN: 978-987-42-5099-5.

Salatino, D. R. (2017d). "Transcurssive Logic as Method." *Inter. J. Res. Methodol. Soc. Sci.*, Vol., 3, No. 3: pp. 5–18. (Jul. – Sep. 2017); ISSN: 2415-0371.

Salatino, D. R. (2017e). "Language production – First part" *Inter. J. Res. Methodol. Soc. Sci.*, Vol., 3, No. 4: pp. 5-21. (Oct. – Dec. 2017); ISSN: 2415-0371.

Salatino, D. R. (2018a). "Language production – Part 2" *Inter. J. Res. Methodol. Soc. Sci.*, Vol., 4, No. 1: pp. 5–17. (Jan. – Mar. 2018); ISSN: 2415-0371.

Salatino, D. R. (2018b). "Language acquisition – Part 1 of 3." *Inter. J. Res. Methodol. Soc. Sci.*, Vol., 4, No. 2: pp. 1-14. (Apr. – Jun. 2018); ISSN: 2415-0371.

Salatino, D. R. (2018c). *La "geometría funcional" como fundamento de la estructura y la función del aparato psíquico*. En Revista de Psicopatología y Salud Mental del niño y del adolescente. (Recibido: 15/4/18 – Aceptado: 30/5/18) Vol. 32 (En Prensa). Fundació Orienta, Barcelona. España.

Samaja, J. (2005). *Epistemología y Metodología. Elementos para una teoría de la investigación científica*. Buenos Aires, Eudeba.

Schwichtenberg, J. (2018). *Physics from Symmetry*. Germany, Springer

Tersoglio, A. E.; Salatino, D. R. et al. (2015). *Repeated implantation failure in oocyte donation. What to do to improve the endometrial receptivity?* JBRA Assisted Reproduction; 19(2): 44-52. doi: 10.5935/1518-0557.20150012.

Tersoglio, A. E., and Salatino, D.R. (2017). "Implantation Failure." *Inter. J. Res. Methodol. Soc. Sci.*, Vol., 3, No. 3: pp. 36-43. (Jul. – Sep. 2017); ISSN: 2415-0371.

Van Fraassen, B. C. (1989). Laws and Symmetry. Oxford, Clarendon Press.

Wright, S. (1921). *Correlation and Causation. Part I. Method of Path Coefficients*. Journal of Agricultural Research, Washington, D. C. Vol. XX, Nº 7.

International Journal of Research & Methodology in Social Science
Vol. 5, No. 1, p.75 (Jan. – Mar. 2019). ISSN 2415-0371 (online)
www.socialsciencepublication.com; DOI: 10.5281/zenodo.2667563

Earning Quality and Growth of Listed Firms in Nigeria

Akintoye, R,I., ★ Adegbie, F.F., ★★ Nwaobia, A.N., ★★★ and Kwarbai, J.D. ★★★★

About the authors

All authors are affiliated with Babcock University, Department of Accounting Ilishan-Remo, Ogun State, Nigeria.

★ AKINTOYE, Rufus I. is a Professor of Accounting & Financial management.

★★ADEGBIE, Festus F. is Head of Department, Department of Accounting and Associate professor of Taxation, fiscal policy & Accounting.

★★★NWAOBIA, Apollos N. is Associate professor of Auditing and Financial reporting

★★★★KWARBAI, Jerry D. is a Lecturer in the field of Auditing and financial reporting.

ABSTRACT

This paper investigated the effect of Earnings Quality (EQ) on the growth of manufacturing firms in Nigeria during the period 1996-2006 using an *ex-post* facto research design. We determined the earnings quality and growth of 26 listed firms in Nigeria. Our findings revealed that the quality of earnings had significant effect on Turnover Growth (TUG). However, earnings quality proxies had mixed effects because Earnings Predictability (EPRE) had a significant negative effect. The Value Relevance (VALR) and Accounting Conservatism (CONS) had a significant positive effect, while Accrual Quality (AQUA) had an insignificant negative effect on Turnover growth of firms. The study concludes that Earnings quality is useful in determining the growth of firms.

Keywords: Accrual quality, business growth, Conservatism, Earnings predictability, Value relevance,

JEL code: D

CITATION:

Akintoye, R,I., Adegbie, F.F., Nwaobia, A.N., and Kwarbai, J.D. (2019). "Earning quality and growth of listed firms in Nigeria." *Inter. J. Res. Methodol. Soc. Sci.*, Vol., 5, No. 1: pp. 74-82. (Jan. – Mar. 2019); ISSN: 2415-0371

1.0 INTRODUCTION

The health of a firm in a highly competitive business environment is dependent upon its capability of achieving profit and maintain financial solvency. When a firm loses competency to maintain profit and financial solvency, it becomes unhealthy and is in danger of business failure leading to total extinction (Akintoye, 2008; Wu, 2010). Since the growth of a business is reported or communicated to the providers of capital and other stakeholders through the financial reports, the reliability of figures presented in the financial report remain of paramount importance to users of financial information. This is because information is demanded by investors in order to assess the timing and certainty of future cash flows to determine the level of growth over a given period of time. It can be argued that the extent to which business organizations report their activities especially as it has to do with finance, may be a factor that could influence business performance and growth of the business organization (Ojeka, Mukoro, Dick, & Kanu, 2015).

Adekunle and Asaolu (2006) identified in their study that financial reports and analysis presented by Nigerian companies have been found to be deficient over time and this is a great concern to investors as their performance in terms of profitability which are measured by turnover or the ratio of profit retention are decreasing by the day. Shehu and Ahmad (2013) also found that

financial information quality in Nigeria remains weak compared to other advanced market, and this has resulted in hampering of the growth of efficient equity market. Hence, this study supports the view that if financial report is of good quality, it will affect profitability and business growth in the long run. Since investors are in need of information, quality information will increase the trading and subsequently growth and expansion of firms.

Our study is slightly related to other works, but is still distinct from prior studies that examined the link between earnings quality with short term performance (Kim, Lee & Choi, 2016; Narjess, Sadok & Walid, 2016; Nwaobia , Kwarbai, Jayeoba, & Ajibade , 2016; Solmaz & Mehdi 2015; Ojeka *et al.,* 2015) but not long term business growth considered pivotal to survival which is the focus of this study. In our view, if the quality of earning can impact the financial performance of, it should also impact the growth of firms. Hence, this study argues that the quality of accounting information can cause market reaction and induce growth and expansion of business on a long run. There is paucity of studies that looked at the direct link of Earnings quality and Business growth in Nigeria. The paper is organized into five sections including this introduction. Section 2 discusses review of literature and development of hypothesis on the effects of financial reporting quality and investor decision. Section 3 explains the methodology, including the choice of variables and their measurement. Estimation results are presented and discussed in Section 4 and Section 5 gives the conclusion.

2.0 LITERATURE

This section provides a review of the theoretical framework and Literature review on earnings quality and firms growth. We begin with the principles underlying this relationship then discuss the empirical literature on variables that affect firm's growth.

2.1 Theoretical Consideration

There are many theories that associate the corporate performance of firms and how internal and external variables affects it, some of which are agency theory, positive accounting theory and stewardship theory which were discussed in this paper (Akintoye *et al.,* 2016). The agency theory is the root and the building block of all corporate performance. It is believed to be the first theory to be considered once the issues of corporate performance appear in a discussion. According to them, this theory could be traced to the USA in the early 1970s. The agency relationship is one between one party (agent) and another, (the principal), where the agent is hired to act for the interest of the principal (Jensen and Meckling, 1976). The agency theory could explain the reason why management uses certain accounting policies to benefit themselves rather than maximizing shareholders wealth. Management incurs agency cost to reduce the activity of the management that is not in alignment with the investor's objectives. Alongside the agency theory is positive accounting theory that assumes that individuals are primarily motivated by self-interest with the aim to maximize their own wealth by selecting an accounting method that can suite their objective. Positive Accounting theory therefore explains the different motive for using different accounting policies and it can explain the sign of the effect on growth of firms as affected by the quality of earnings. We deduced that management can manipulate accounting information for several reasons aside in order to achieve their selfish desire. However, the stewardship theory, as proposed by Friedman in 1970, negates the assumption of agency theory and positive accounting theory that directors will fulfill their duties towards the shareholders and assumes that human beings are good and the directors are trustworthy. Hence, the stewardship theory suggests that the stakeholder theory replaces the sole aim of maximizing the value of shareholders to include the satisfaction of all major stakeholders. This suggests that the management will make good choices that will bring about growth and expansion of the business.

2.2 Empirical Review and Hypothesis development

Several studies have attempted to analyze the effect of earning quality on different component of performance of corporate firms and the need to make appropriate disclosure for the use of investors performance (Kim *et al.,* 2016; Narjess *et al.*, 2016; Nwaobia *et al.,* 2016; Solmaz & Mehdi 2015; Ojeka *et al.,* 2015). For instance, Kim *et al.* (2016) highlighted that investor's demand information in order to assess the timing and uncertainty of current and future cash flow so that they may evaluate firms and make other investment decisions. The extent to which a firm reports its activities significantly impacts to its profitability and growth (McMahon, 1996).

Ghosh *et al.,* (2010) explored the effect of earnings quality and earnings response coefficients using turnover growth as proxy. They documented that earnings are of higher quality when growth in earnings is supported by revenue increases rather than through cost reductions. In their view revenue-supported earnings growth is likely to be more sustainable because revenue is the key value driver and its growth often reflects the underlying product differentiation strategy. Moshi (2016) evaluated the impact of earnings management on firm's financial performance in Tanzanian manufacturing companies and their findings showed that earnings management has negative impact on firm's financial performance. This was corroborated by the further findings that most of the firms managed the earnings, suggestive of lack quality and adequate disclosure.

Pranesh (2017) analyzed the nature and extent of earnings management practices on growth and performance of India firms. Regression analysis of the study showed that growth of the firm is positively associated with discretionary accruals while performance is negatively correlated. Nonetheless, among the other control variables viz firms' size and age were also found statistically significant influencing variables.

The relationship between earnings quality and firms growth in extant literature are mixed. For instance, Beaver (1968) research shows that growth opportunities provides managers with incentive to smooth earnings as earnings volatility increase perceived firm risk which adversely affect the cost of capital needed by the firm. Penman and Zhang, (2002) and Chan *et al*. (2006) documented an inverse relationship between the quality of earnings and growth firms. In their findings, sales or net operating assets are accompanied with lower earnings quality. Also Ma and Ma (2017) established a negative association between Chinese publically listed firm's performance and earnings quality, suggesting that the quality of earning exerts a negative effect on corporate performance.

The relationship between earnings quality and firm growth is not straightforward or conclusive. We join other researchers in the developed world to posit that the quality earnings will bring about growth of business. We therefore hypothesized that: ***The quality of earning affect the growth of firms in Nigeria.***

3.0 METHODOLOGY

The *ex-post facto* research design was adopted in this study. Secondary data were extracted from the annual reports and accounts of twenty six (26) companies for a period of 21 years (1996-2016) representing 546 firm-year observations. To achieve the objective of this paper, three variables were identified and discussed in this section. We defined dependent variable as the growth in turnover, independent variable as earnings quality, control variables are Age and size. First, in determining earning quality we used four proxies of earnings quality which are: earnings predictability by Francis *et al*. (2005), Value relevance by Feltham and Ohlson (1995), Accounting Conservatism and accrual quality by Dechow and Dichev (2002), and modified by McNichols and Stubben (2008) and Kothari *et al*. (2005). Secondly, we analyze the effect of earnings quality on growth of firms in the Nigeria. Thirdly, we include Corporate Age and Corporate Size as control variables and analyze their influence on growth of firms.

Earnings quality is one of the most important accounting research topics of the last few decades. However there is neither an agreed-upon meaning of the concept nor a generally accepted approach to measuring earnings quality (Schipper and Vincent, 2003). Earnings quality is

considered a multidimensional concept that is difficult to measure, and recent research evaluates various earnings attributes (Francis *et al*., 2004; Dechow *et al*., 2010).

We draw upon prior research to identify other factors that can affect the casualty of quality earnings and firms growth. We included Corporate Age and Corporate Size to the model According to Nwaobia *et al.,* (2016) size and age variables could be used to control for the economics factors that influence firm's growth. The measurement procedures of these variables are shown in table 3.1 below.

Table 1. Variable measurement

Variables	**Abbr**	**Definition**
Earning Predictability	EPRE	According to Francis *et al* (2005), earnings predictability is measured using the square root of the error variance from Karmedi and Lipe's (1987) model of earning persistence. First we will make autoregressive model AR(1) for annual earning $X_{j,t} = \beta_0 + \beta_1 X_{j,t-1} + \varepsilon_{j,t}$ or the we use earnings persistence result as suggested by Francis *et al.* (2005) then take square root of the error variance of AR(1) $\sqrt{\sigma^2(\varepsilon_{j,t})}$
Conservatism	CONS	$CONS = \frac{MPS}{BVS}$ where BVS is Book value $BVS = \frac{\text{Net Asset value}}{\text{Total Outstamding Ordinary Share Capital}}$ MPS: The stock exchange market share price at the end of financial firm year
Value Relevance	VALR	Feltham and Ohlson (1995) presented a valuation model that, in contrast to Easton and Harris's, explicitly relates the book values of equity and earnings with stock price. In statistical notation, the model is as follows: $MPS_{i,t} = \alpha_0 + \alpha_1 BVS_{i,t} + \alpha_2 EPS_{i,t} + \varepsilon_{i,t}$ where $MPS_{i,t}$ is the stock price of firm i at time t, $BVS_{i,t}$ is the book value of equity of firm i at time t, divided by common shares outstanding, and $EPS_{i,t}$ is Earnings per share of firm i at time t. The Feltham and Ohlson model was used in this study as it measures the mean annual level of statistical association between book values of equity, earnings, and stock prices. The Ohlson (1995) is chosen in this present study because it measures the long term relationship between accounting information measures and share prices.
Accrual quality	AQUA	Our accruals quality measure is derived from the Dechow and Dichev (2002), hereafter referred to as DD. The DD model is based on the extent to which working capital accruals map into cash flow realizations, where a poor match means low accruals quality. Therefore, we regress working capital accruals on prior, current, and future cash flows from operations $TCA_{it} = \beta_0 + \beta_1 CFO_{it}\text{-}1 + \beta_2 CFO_{it-1} + \beta_3 CFO_{it+1} + \beta_4 \Delta REV_{it} + PPE_{it} + \varepsilon_{it}$

		where: $TCA_{it} = (\Delta CA_{it} - \Delta Cash_{it}) - (\Delta CL_{it} - \Delta STDBET_{it}$
TOG	Turnover growth	$\frac{\text{Current Turnove - Previous Turnover}}{\text{Previou Turnover}}$
CORPSIZE	Corporate Size	Estimated as natural logarithm of total assets
CORPAGE	Age of the firm	The age of a firm (AGE) is defined as the absolute number of years of incorporation

The Model specification

TOG = f (EPRE, AQUA , CONS, VAR, CORPAGE, CORPSIZE) (1)

$$TOG_{it} = \alpha_0 + \alpha_1 EPRE_{it} + \alpha_2 AQUA_{it} + \alpha_3 CONS_{it} + \alpha_4 VALR_{it} + \alpha_5 CORPAGE_{it} + \alpha_6 ORPSIZE_{it} + \mu_{it} \quad (2)$$

4. ANALYSIS, RESULTS AND DISCUSSION

4.1 Descriptive Statistics

Table 4.1 presents the descriptive statistics of the data. It presents the mean, maximum, minimum and standard deviation, from all quantifiable variables used in the model.

Table 2. Descriptive Statistics

VARIABLE	OBS	MEAN	SD	MIN	MAX
CORPAGE	546	43.615	15.318	10.000	93.000
CORPSIZE	546	6.828	1.053	4.036	10.014
TURNGRWT	546	2.238	43.011	-0.998	999.000
EPRE	546	-2.450	0.542	-2.888	11.307
EQUA	546	-7.730	60.290	-483.406	103.667
VARL	546	-58.922	384.946	-4685.825	2460.405
CONS	546	-427.132	13240.040	-262592.400	55490.000

From the reported descriptive statistics, corporate age (CORPAGE), the age of the sampled firms used are within the range 10 years to 93 year of existence. This indicates that the firms under consideration are experienced in their respective areas of business endeavors due to the long duration of their corporate existence. Firms reacts differently to how they prepare quality report according to their experience over time in the industry in which the operate. There is also an indication that sampled firms have large balance sheet size (CORPSIZE) using log of total asset as proxy. CORPSIZE has a minimum value of 4.036 billion and a maximum value of N10.14 billion, suggesting that the firms are large firms.

The descriptive statistics also shows that Turnover Growth (TUG) has a minimum value of -0.998 and maximum of 999.00. The mean and standard deviation value is 2.238 and 43.011, respectively. The minimum, maximum and standard deviation suggest a broad variation away from the mean and as such the variable is volatile in nature.

For earning predictability (EPRE), Accrual Quality (AQUA), Conservatism and Value relevance of accounting earnings, the minimum, maximum; mean and standard deviation suggest low variation. The mean value which is also lower than the standard deviation also indicates low variation for earning predictability.

4.2. Regression Result

Table 3. Regression Analysis with Driscoll-Kraay standard errors for Model

Variable	**Coefficient**	**Std Error**	**t-Stat.**	**Prob.**
C	14.2092	1.6512	8.65	0.000*
EPRE	-2.1046	0. .3005	-7.00	0.000*
VALR	0.0158	0.0017	9.01	0.000*
CONS	0. 0010	0.0001	7.84	0.000*
AQUA	-1.30006	4.03006	-0.32	0.748
CORPAGE	-0.1078	0.0131	-8.20	0.000*
CORPSIZE	-1.5130	0.1682	-8.99	0.000*
R-squared	0.3904			
Adjusted R-squared	0.3820			
F-Statistic	46.83			
Prob.(F-Stat)	0.000*			
Diagnostic Tests	**Statistics**			
Hausman test	89.62			0.000*
Heteroskedasticity test	91689.30			0.000*
Wooldridge test for autocorrelation	1053.680			0.000*
Pesaran's test of cross sectional independence	7.309			0.000*

Dependent Variable: TUG; Obs.:546 *significant at 5%
Source: Researcher's Computation, 2018

The result of the post estimation tests on Table 4.2 shows that all the various tests are significant with probability values of 0.000, which is less than the acceptable 0.05 level of significance. Specifically, the significance of hausman test shows that the null hypothesis to estimate random effect was rejected; as such the model was tested for the appropriateness of random effect using the testparm option on stata. In addition, the Breusch-pagan heteroskedasticity test showed a p-value of 0.000, implying that the null hypothesis of constant variance was rejected and there is presence of heteroskedasticity. As such, if predictions are based on their regression estimates, it will be biased and inconsistent. Furthermore, the Wooldridge test for autocorrelation is significant at 5% which implies that there is presence of first-order autocorrelation. This indicates that the residuals are correlated over time. The Pesaran's test of cross sectional independence shows that the residuals are cross sectionally correlated at 5% level of significance. Thus, in line with Hoechle (2007), the presence of heteroskedasticity, first-order autocorrelation, and cross sectional dependence indicate the need to use Driscoll and Kraay standard errors to estimate the model to avoid estimation bias. Therefore, the model was estimated using Driscoll and Kraay standard errors.

4.3 Interpretation of Result and Discussions

The result of the regression analysis on Table 4.1 shows Earning Predictability (EPRE) and Accrual quality (AQUA) have negative effect on Turnover growth. This is indicated by the signs of the coefficients, that is α_1 = -2.104683 <0; α_2 = -1.30006 >0. This result is inconsistent with *a priori* expectation as it was expected that accounting base measures of Earnings Quality (EQ) will have positive effects on the growth of firms. However, VARL and CONS exerted positive effects on firms growth (that is α_3 = 0.0158 <0; α_4 = + 0.0010) respectively. The control variables CORPAGE and CORPSIZE exerts negative effect on turnover growth as indicated by the coefficients α_5 = -0.1078783 <0; α_6 = -1.51308. Likewise, the P-value of the individual t-statistics shows that Market base EQ measure have significant effects on Business growth at 5% level of significance acceptable in this study.

The adjusted R-squared showed that about 38% variations in Business growth can be attributed by the quality of earnings while the remaining 62% variation is caused by other factors not included in this model. Our explanatory variables suffered from series of transformation, we used the residual values of the earnings quality estimate according to Dechow and Dechev (2005)

and this must have accounted for the low adjusted R-squared. To the best of of our knowledge, there is no possible variable that was left out in the model as both market and accounting base measures of earnings quality were used. The coefficient of determination shows that the main model has average explanatory power. This is further emphasized by the probability of the F-statistic of 0.000 which shows that the regression result is statistically significant because this is less than 5%, the level of significance adopted for this study.

In addition, at the level of significance of 0.05, and F-statistics of 46.83 and p-value of 0.00, the null hypothesis that financial reporting quality has no significant effect on turnover growth of manufacturing firms in Nigeria is not accepted. Therefore, from the regression estimates, EQ measured by EPRE, AQUA, VALR and CONS jointly have significant positive effect on turnover growth of manufacturing firms in Nigeria.

However, considering the individual coefficients separately, the regression analysis shows Earnings predictability and accrual quality had a negative significant and insignificant effect on turnover growth respectively, value relevance and conservatism had a positive and significance effect on turnover growth of Nigeria manufacturing firms. Our findings are consistent with the body of literatures that posit that quality of earnings improves the growth of businesses. Although, some argued that, a growing firm engages in earnings smoothing which reduces the quality of the reported earnings. As earlier indicate Beaver (1968) study shows that growth opportunities provides managers with incentive to smooth earnings as earnings volatility increase perceived firm risk which adversely affect the cost of capital needed by the firm. Our findings are consistent with Pranesh (2017) that growth of the firm is positively associated with discretionary accruals while performance is negatively correlated.

Pranesh (2017) also indicates that firm's size and age were statistically significant influencing variable on the relationship of earnings quality and firms performance, although our result indicates negative influence. This finding is in line with the work of Beyer (2008) that suggested that an investor wishes to transact with firms with growing turnover.

5.0 CONCLUSION AND RECOMMENDATIONS

This study examined the effect of Earnings quality on growth of listed firms in Nigeria. The model is statistically significant at 5% level of significance. Findings of this study provide insight into the effect of earnings quality on growth of firms in Nigeria. It further provide an insight as to the extent to which each of the independent variables of earnings quality influences the dependent variable of growth. It also provides an affirmation of the extent to which the variations in the dependent variable are caused by the independent variables covered in the models as depicted by the adjusted R-squared.

The study concluded that earnings quality is a predictor of firm growth and that firm size and age can influence the relationship between earnings quality and firm growth. The overall result of the regression analysis shows that earnings quality has a significant effect on growth of firms in Nigeria for the period under review although, the explanatory power is low but causality exists. The controlling variable used in the models also affects the relationship between earnings quality and firm's growth although depending on the association under consideration.

The study recommends that since aggressive earnings management reduces the quality of earnings, standard setters and regulators should curb creative accounting practices by removing loopholes in the use of judgments and managerial discretions in the estimation of assets and liabilities. Managers should embrace ethical values in reporting through providing quality accounting information that reflect the actual activity of the firms to foster the confidence of investors and owner of business. At all times, managers should avoid aggressiveness earning management which connotes negative manipulation of accounting information.

REFERENCES

Adekunle, A. A., & Asaolu, T. (2013). An empirical investigation of the financial reporting practices and banks 'stability in Nigeria. *Arabian Journal of Business and Management Review*, **2**(5), 157.

Akintoye, I. R., Jayeoba, O. O., Ajibade, A. T., Olayinka, I. M., & Kwarbai, J.D (2016). Value of accounting numbers and analysts 'forecast errors. *International Journal of Research Methodology in Social Science,* **2**(3). 17-32.

Akintoye, I.R (2008). Optimizing Investment Decisions through informative Accounting, *European Journal of Social Science*, **7**(3), 178-191

Beaver, W. 1968. The information content of annual earnings announcements. *Journal of Accounting Research*. (Supplement): 67-92.

Chan, K.., Chan, L., Jegadeesh, L. and Lakonishok, J. (2006). Earnings Quality and Stock Returns", *Journal of Business*, **79**, 1041–1082.

Dechow, P., G W., & Schrand, C. (2010). Understanding earnings quality: A review of the proxies, their determinants and their consequences. *Journal of accounting and economics,* **50**(2-3), 344-401.

Francis, J., LaFond, R., Olsson, P. and Schipper, K. (2004). Costs of equity and earnings attributes, The *Accounting Review*, **79**, 967−1010

Ghosh, A., Gu, Z., & Jain, P. C. (2010). Sustained earnings and revenue growth, earnings quality, and earnings response coefficients. *Review of accounting studies*, **10**(1), 33-57.

Gray, S., Meek, G., & Roberts, C.,. (1995). Factors influencing voluntary annual report disclosures by US, UK and continental European multinational corporations. *Journal of international business studies*, **26**(3), 555-572.

Jensen, M.C. & Meckling W.H. (1976). "Theory of the firm: managerial behaviour, agency cost and ownership structure." *Journal of Finance Economics* **3**(4). 305-360

Kim, J., Lee, C. Y., & Cho, Y. (2016). Technological diversification, core-technology competence, and firm growth. *Research Policy*, **45**(1), 113-124.

Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.

Ma, S., & Ma, L. (2017). The association of earnings quality with corporate performance: Evidence from the emerging market of China. *Pacific Accounting Review,* **29**(3), 397-422

McMahon, R.G.(1996). Business growth and performance and the financial reporting practices of Australian manufacturing SMEs. School of commerce, *Journal of small Business management.* **39**(2), 152-164.

Narjess, B, Sadok, E.; and Walid, S. (2015). Firms growth and political institutions, *Journal of Multidisplinary Finanacial. Management* **31**.

Nissim, D., & Ziv, A. (2001). Dividend changes and future profitability. *Journal of Finance*,56, 2111– 2133.

Nwaobia, A.N, Kwarbai J.D, Jayeoba O.O, and Ajibade A.T (2016). Financial reporting Quality and investors decision. *International Journal of Economics and Financial Research.* **2**(7)140-147.

Nwaobia, A. N., Kwarbai, J. D. and Ogundajo, G. O. (2016). Tax planning and firm value: Empirical evidence from Nigerian consumer goods industrial sector. *Research Journal of Finance and Accounting* **7**(2). 172-183

Ojeka, S.A., Mukoro A., Dick O. and Kanu, C. (2015). Does Financial Reporting Disclosures Enhance Firm Financial Performance in the Nigerian Manufacturing Companies? *Mediterranean Journal of Social Sciences, MCSER Publishing, Rome-Italy* **6**(6).

Penman, S. H. (2003). The quality of financial statements: Perspectives from the recent stock market bubble. *Accounting Horizons* **17**, 77-96.

Pranesh, D. (2017) Assaying the Impact of Firm's Growth and Performance on Earnings Management: An Empirical Observation of Indian Economy. *International Journal of Research in Business Studies and Management* **4**(2).

Raymond, P. (2010). The relation between growth opportunities and earnings quality: A cross-sectional study about the quality of earnings for European firms with relatively high growth opportunities. *Review of Quantitative Finance and Accounting*. 1-19

Schipper, K. and Vincent, L. (2003). Earnings quality", *Accounting Horizon*, **17**, (Supplement), 97–111.

Shehu, U,.H and Ahmad B. (2013). Firm characteristics and Financial Reporting quality of listed manufacturing firms in Nigeria. *International Journal of Accounting, Banking and management* **1**(6) 47-63.

Solmaz, H and Mehdi (2015). The sales growth and growth potential effect on financial reporting quality at listed companies in Tehran stock exchange. *Arabian Journal of Business and Management Review (OMAN Chapter)* **4** (7).

Wu, W. (2010). Beyond Business Failure Prediction. Expert Syst. Appl., **37**: 2371-2376.

International Journal of Research & Methodology in Social Science
Vol. 5, No. 1, p.84 (Jan. – Mar. 2019). ISSN 2415-0371 (online)
www.socialsciencepublication.com; DOI: 10.5281/zenodo.2667563

The Logic within the Logic
Reinterpretation of Boolean algebra from Transcurssive Logic

Dante Roberto Salatino★

About the author

★Dante Roberto Salatino is a researcher of the Institute of Philosophy and of the Institute of Linguistics - Lecturer in the General Psychology Department – Lecturer in the Philosophical Aspects of Physical-Mathematical Science Department - Faculty of Philosophy and Letters - Teacher and Researcher in Artificial Intelligence in the Mechatronics Career - Faculty of Engineering - National University of Cuyo - Email for correspondence: dantesalatino@gmail.com

ABSTRACT

In the introduction of Boole's "Mathematical Analysis of Logic" of 1847, he approaches one of the operative foundations of Transcurssive Logic. He tells us that "those who are familiar with the theory of symbolic algebra, know that the validity of their analysis does not depend on the interpretation of the symbols, but only on the laws of their combination." This statement makes very clear the preponderance that Boole gives to relationships. In response to this interest in the relational, we proposed to try to understand, how it was that Boole gave an algebraic form to logic. To carry out this task, we decided to use the principles that govern Transcurssive Logic (TL). The analysis of the categorical propositions was initiated: universal affirmative, universal negative, particular affirmative and particular negative. In analyzing the latter, we discovered that a whole universe could be described only from it. That is, not only told us that, for example, "some **a** is not **b**", but also could tell us: that there is "**a** which are not **b**", that there is "**b** that is not **a**", that there is "**a** which is **b**", and that in the rest of the universe there is "something" that "is not **a** nor is **b**". Then, from the TL it was inquired about the relationships that link these contents to try to determine how this algebraic structure could be generated. After some steps, four elements that resulted from this inquiry were given an entity; by relating them, they formed an algebraic structure called the permutation group or Galois group. The structure that constitutes the "universal language" in which the TL is written. In the analysis of the basic principles on which Boole's algebra is based, we have discovered that some aspects of reality that are revealed when we approach it from the subjective hidden between its values of truth and functions. That is, there is an 'implicit logic' underlying the Boolean binary proposal, a logic that we have called 'transcurssive' because it leaves evidence of a particular evolution over time, of what affects an observer. Among the findings, are: a) the existence of a complex system based, not on its constituent elements and a specific purpose, but on the interrelations that link its components. b) a systemic complexity that enables an adaptive dynamic response in front of the demands (inputs). c) the possibility of analyzing through the discovered structure, the relational situation of several binary systems, simultaneously (heterarchical distribution of hierarchical systems). d) the functional non-dependence of the structure concerning the observer (measurement process), as it is the case with any situation that is objectively addressed, and e) the advantage of being able to consider situations where more than two states are at stake, even if they are exclusive. From the transcurssive perspective, an interesting panorama opens up of possible applications of this way of observing reality.

Keyword: logic, Boolean algebra, subjective reality, transcurssive logic.

CITATION:

Salatino, D. R. (2018). "The logic within the logic. Reinterpretation of Boolean algebra from Transcurssive Logic" *Inter. J. Res. Methodol. Soc. Sci.*, Vol., 5, No. 1: pp. 83-99. (Jan. – Mar. 2019); ISSN: 2415-0371.

International Journal of Research & Methodology in Social Science
Vol. 5, No. 1, p.85 (Jan. – Mar. 2019). ISSN 2415-0371 (online)
www.socialsciencepublication.com; DOI: 10.5281/zenodo.2667563

1.0 INTRODUCTION

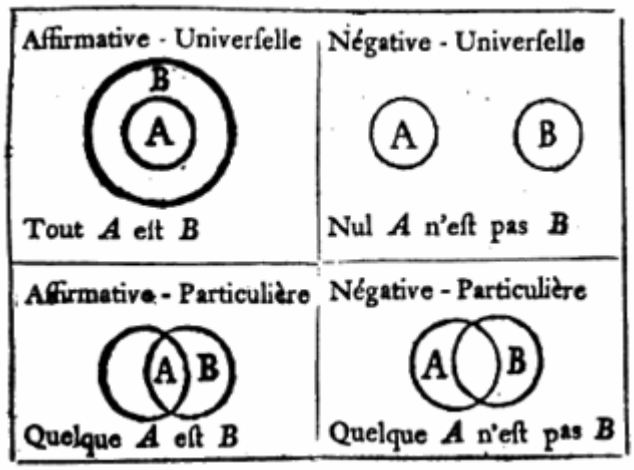
> "They who are acquainted with the present state of the theory of Symbolical Algebra, are aware, that the validity of the processes of analysis does not depend upon the interpretation of the symbols which are employed, but solely upon the laws of their combination." George Boole, 1847, p. 3.

The introduction that Boole makes in his "Mathematical Analysis of Logic" approaches one of the operative foundations of Transcurssive Logic (TL), which is to generate a structure that can be modified using functions. Even more so when he completes it by saying: "Any system of interpretation that does not affect the truth of the supposed relationships is equally admissible."

To understand how Boole gave an algebraic form to logic, we will use the TL principles; we will approach it from the perspective of the subject. We undertake this task knowing that logic, from its beginnings, was defined as objective. Thus, in the first book of the Aristotelian "First Analytical," there is no mention of subjective factors. It is not since Aristotle where modern logic takes its severe objective attitude, but from the mathematics that he wanted to imitate in the initial Boolean period. (Bochenski, 1981, p.10)

A Boolean algebra is an 'algebraic structure', that is, a classifier of sets according to the elements they contain and is defined by any set in which we have, at least, two different and opposite elements to represent them, let's say ' 1 'for affirmation and' 0 'for its opposite, denial (Del Vado Virseda, 2017, p.80). We appeal to the Euler logical diagrams to better understand this structure.

Fig. 1. Categorical preposition



(Image of the original, Euler, 1768, p.101)

> "Since a general notion contains an infinity of individual objects, it is considered space where all individuals are contained. Thus, for the notion of 'man,' we create a space where all men are contained. For the notion of 'mortal,' we also create a space where all mortals will be contained. Then, when I say that all men are mortal, it is equivalent to the fact that the first figure is contained in the second." (Euler, 1768, Lettre CII, p.98) (Own Translation).

Thus, Euler represented four categorical propositions: universal affirmative, universal negative, particular affirmative and particular negative (Figure 1).

2.0 PARTICULAR NEGATIVE PROPOSITION - A NEW UNIVERSE

We will take the particular *negative proposition*: *some A is not B*, to face our analysis of Boole's work (Figure 2).

Fig. 2. Particular negative production

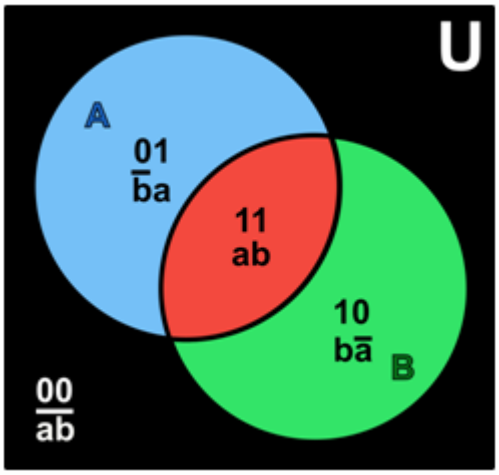


Figure 2 shows that in the superposition of two sets, in fact, four general regions are formed. Let's see: of a universal or fundamental set **U**, we can say that it is 'inhabited' by two subsets: **A** and **B**, which when 'overlapping,' shows us that there is a subset of **a** that is not **b** (01). That there is also a subset of **b** that is not **a** (10). And instead of *some, **a** is not **b***; there is a subset of **a** that is also **b** (11). All these subsets are 'inhabiting' a universe **U** where there is no more **a** nor **b** (00) than those cited (Nahin, 2013, p.45).

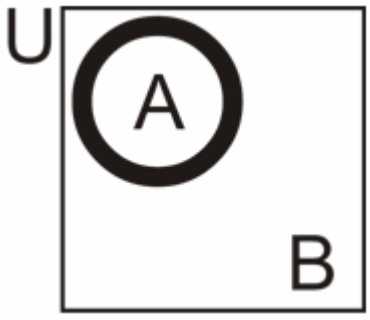
Suppose that **A** represents women and **B** represents the right-handed people of this universe. The scheme is showing us that the universe **U** is populated by left-handed women (01), by right-handed men (10), by right-handed women (11), and by left-handed men (00). Then, the previous graphic rather than telling us that *some woman is not right-handed* shows us all the content of that universe and its distribution. That is, it identifies the diverse content of the structure.

3.0 ALGEBRAIC STRUCTURE

The TL also inquired about the relationships that link the previous contents. Next, we will see how this algebraic structure could have been generated.

Let **U** be an *ad hoc* universe that determines the *scope* (See Appendix A) of a given *function* and **A** *class* (See Appendix A) included in this universe, which we will generically call “disorder”, and which represents the *domain* (See Appendix A) of such a function (Figure 3).

Fig. 3. Universe

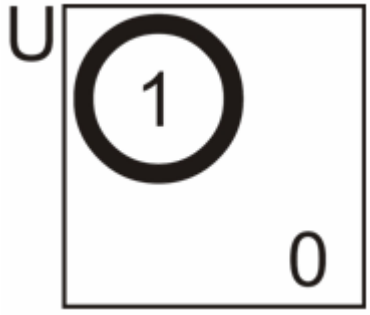


We will call in turn, *ambit* or *contexture* of **A** to the set of elements that belong to it. In this case, the “disorder” and we will denominate content of A, all the elements that do not belong to it.

That is to say, what belongs to its *complement* (**B**) that will also be a contexture and that generically we will call "order" (absence of disorder).

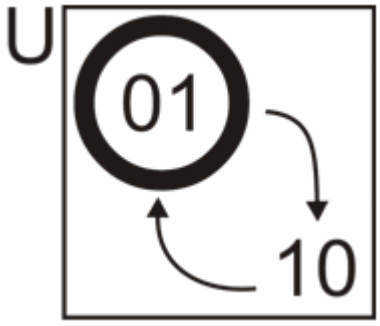
If we symbolize with "1", the belonging to the *ambit*, the belonging to the *content*, we will do it with "0" (Figure 4).

Fig. 4. Contexture-universe relationship



For any element of **U**, each contexture is determined, in reality, by two values (Figure 5) that are interpreted in the following way: '1' belongs to the contexture considered and '0' belongs to the "complementary contexture" (its absence).

Fig. 5. Contexture

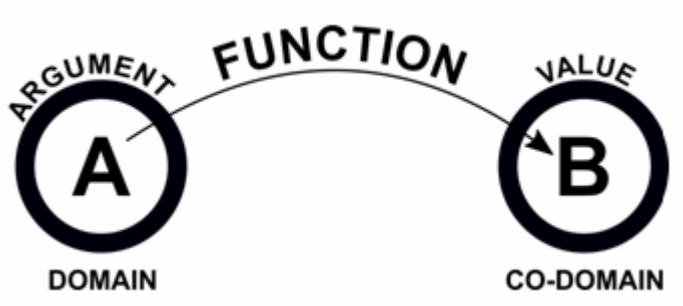


This pair of values is linked to a double relationship: they are opposite (one is the negation of the other), and they are complementary (added together give the unit). The same is true considering them in pairs. If we represent **A** and **B** by their "contexture values" and in a paired form, we have **0110**. If we deny (we determine the opposite of) these values, we obtain **1001**. This could be defined as the establishment of a cyclical dynamic that would be given by the tendency to go towards "order" (10) through "disorder" (01) and vice versa. Also, as the group of transformations necessary to preserve the symmetry of an algebraic invariant (Noether, 1908, 1918), as we shall see. This dynamic becomes evident when we successively deny a contexture in its entirety, without being annulled, as in the traditional negation (See Appendix A). Everything happens as if he denied the "continent" of the elements belonging to the contexture and not the property of the elements themselves (the content). This dynamic is a dyadic relationship (links two classes) established between classes of "ordered pairs" of values (See Appendix A).

3.1 Function

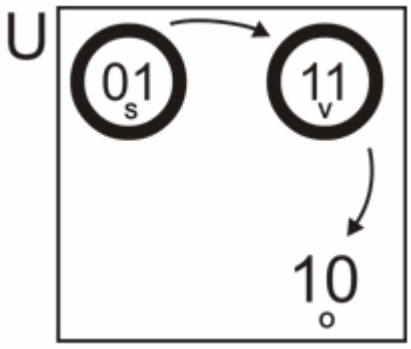
There is another type of relationship that can be established in this universe. This relationship is of a particular type that we will call 'functional relationship' or *function*. Here, function assigns an element of the **contexture** or *continent* to an element of the *content*. We say that the *function* projects the *continent* in the *content*. Or in another way, a set of structures is projected in another set of structures. We will call this projection *transformation* or change. (Figure 6).

Fig. 6. Function or transformation



For each structure that "enters" into the transformation there is a structure that "leaves" it. With this, we characterize a "third contexture" in our universe (Figure 7). This contexture is not evident when we consider the static universe, but when we put it in "movement" through successive denials of the continent of our "base contexture," a "mediating contexture" appears that leaves a record of this happening in its structure. The way it has to record what happened is "trapping" in its own continent the elements that define the content of each "related contexture." For that reason, its representation is 11, which certifies that both "opposite poles" (continent and content) of our original universe, are simultaneous. We will call this new contexture "organization".

Fig. 7. Organization



The organization transcends the mere structure to leave evidence of the interrelation between two contextures. It manages the "place" for two values (those of the contextures it relates), acting, as well as a kind of "memory" of bivalent system distribution, which, being denied in this way, does not disappear.

It is created like this a triadic relationship (because it relates three contexures) that registers a "mediated negation" (Hegel, 2011, p.419). The passage from one pole to its opposite (something that promotes any negation) is "mediated" by a transformation. Therefore, the pole of origin (argument or **domain** of the function, Source of change) does not disappear but is represented in the structure (scope or continent) of the "mediating contexture" so that, in a later step, it can reach the opposite pole (value or **co-domain** of the function. Destination of the change), having conserved the origin pole (both poles are present simultaneously, despite being exclusive). If we change the binary numbers (01,11,10) by their decimal equivalents (1,3,2) we see that the negation of 1 (01) is not 2 (10) (its opposite pole) but 3 (11) and that the negation of 3 (11) is not 0 (00) (the opposite of 11 is 00) but 2 (10). Mediated negation is really a conservative displacement, such as Hegel's *aufheben*, or the "as if" of Hans Vaihinger (1911).

It should be noted that the structure that we have outlined does not follow the laws of classical logic as does the structure defined by Boole. For example, the negation of the negation (double negation) does not give an affirmation (the same element from which it came out – See Appendix A), but as a result, the opposite pole is obtained (as in a traditional negation), without losing the terms involved. This mechanism also does not follow two of the basic principles of the

Aristotelian logic, which Boole does respect (See Appendix A). The 'principle of non-contradiction', since the opposite ends are both present in the same situation and the 'principle of the excluded third', already that between one end and the other there is a third entity that has common elements with the two extremes (in equal parts), and is also present simultaneously with them.

This triadic relation created, in our opinion, adequately represents a 'living' universe (it can evolve) in one of its basic aspects: its superficial or apparent structure. We call this structure complex because its elements have a triple relationship with each other, they are opposites, complementary and concurrent (or simultaneous) (Morin, 1977, p.101).

3.2 Structure

Why do we say that what we have just analyzed is a structure? We say it because it complies with the guidelines established by Piaget (1985, p.6) for all structures. Let's see:

1º) It is a set of transformations that involves laws as a whole (as opposed to the properties of the elements) that is conserved or enriched by the same game of its transformations without these reaching a result outside its borders or claiming some exterior elements. That is, it complies with the following characteristics:

- totality
- transformation
- self-regulation

Let us analyze it carefully under the three characters posed by Piaget:

• It is a whole because it is made up of elements subordinated to the laws that characterize the set (laws or compositional operations) that are not reduced to 'cumulative associations' but give this set, properties different from those of the constituent elements. As Piaget says, what counts is not the elements, nor the whole, but the relations between the elements. The whole is the result of the relations of composition whose laws are what determine the whole through its unity.

• There is a transformation that in our case is a function, the change that plays an organizational role.

• There is self-adjustment (self-regulation) because there is conservation and 'certain closure' since the process does not lead beyond its borders, generating elements that only belong to the structure and thus preserve its laws. That is, it respects the laws of symmetry: conservation and invariance (Noether, 1918).

3.3 Composition operation

What is the law or operation of composition in this case? The whole structure that we have tried to determine starts with two values: 0 and 1 (as in the algebraic structure of Boole) that represent the 'absence' and the 'presence' of a single element, respectively.

As we saw, the function is a method to assign to each element of its scope, a single element of its domain. Theoretically, the number (N) of these functions can be infinite and depends on 1) the number (n) of class variables (in this case it is equal to 1, and we will call it S); 2) the number (m) of class values, in this case is equal to 2: '0' and '1', and 3) the number (c) of combinations that we can make of these two values. The formula (Peirce, 1958, CP.4,260) that allows us to calculate the number of possible functions is: $N = C^{m^n}$ therefore, $N = 2^{2^1} = 4\,functions$. These functions (f_n) can be expressed as shown in Table I.

Table 1. Functions

	f_1	f_2	f_3	f_4	
S	3	2	1	0	→ decimal
0	1	1	0	0	
1	1	0	1	0	
	V	O	S	∇	→ contextures
	$\bar{S}^{*}$			$\bar{V}^{**}$	

*It means No S or denial of S and is equivalent to O
** It means No V or denial of V and is equivalent to ∇

Table I shows that each of the detailed functions constitutes a contexture to which we have assigned a name, in addition to its decimal equivalent. Other details to consider are a) the contextures of the second half of the table (S and ∇) are complementary and opposed to those of the first half (V and O), and b) the contexture S is the contexture of which we start (S = 01 = 1).

In class logic, class operations serve to compose complex classes from simple classes. These operations are: union, intersection, and complement.

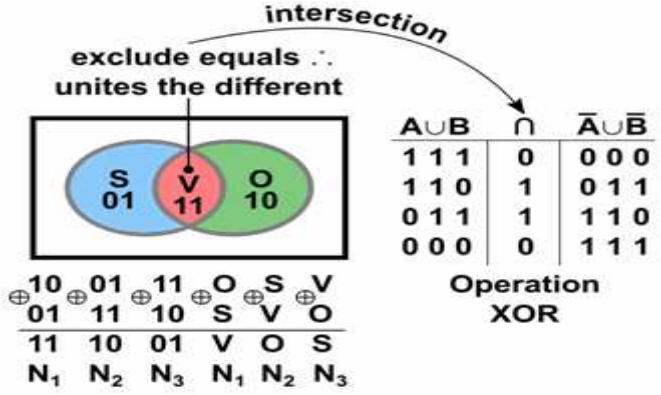
The union of classes (∪) has the same properties as the inclusive (inclusive) disjunction between propositions (although here it is not a truth function). An intersection of classes (∩) has the properties of a propositional conjunction. The complement of a class (~) has the properties of a propositional negation.

The only possible operation between **S** and **O** so that both values obtained are true (1) is the union (governed by the propositional disjunction), which is expressed in contexture **V**. Now, if we remember what **V** represents, we observe that this operation it is a very particular union (disjunction).

A contexture is different from another when there is at least one property that is not common to it, and that property may not belong to the contexture in question. It is enough that it can be attributed to one or the other, but not both simultaneously. Therefore, what V expresses is that only the different properties of the contextures it relates are included in its scope, excluding the equal properties. This union is called exclusive (as opposed to inclusive that contemplates or includes the same properties) and has the same properties as the exclusive disjunction (XOR).

Then the definition here would be: "An element belongs to the scope of the exclusive union of two contextures (A⊕B) when it belongs at least to the scope of one of them. And it will not belong to the scope of this union when it belongs to the scope or content of both. " (Fig. 8).

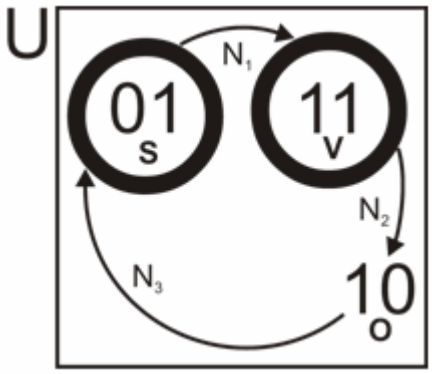
Fig. 8. XOR



If we apply this operation to our textures, we will see what is shown in the lower part of Figure 8. The union of the successive contextures results in the following contexture. There is a 'displacement' equal to that recorded during the successive negations N1 and N2. This confirms that the composition operation of our triadic structure is ⊕ (exclusive disjunction or XOR). If we apply this operation once again to our structure, we will verify that it is equivalent to a third negation: N3.

The result surprises us: the obtained contexture is the one from where we left: S (01). This constitutes a structure of cyclical appearance as shown in Figure 9.

Fig. 9. Superficial cyclical structure



Now this surface structure of **U** is complete. A structure that cycles "jumps" (See Appendix A) through time, indefinitely, posing a kind of “relationship” between the "real" actors of this universe.

3.4 Profound cyclical structure

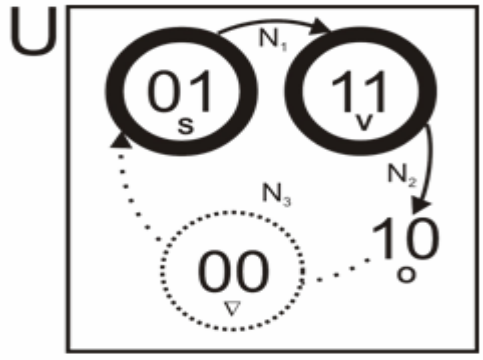
In the reality of this proposed universe never better characterized this process that we have seen as superficial or apparent structure since, it is not the only thing that happens.

If we look closely at Figure 9, we will notice that the third negation (N_3): the displacement of O (10) → S (01), is not different from a classic negation. Then, why did not O (10) disappear?

The explanation is that N_3 appears to be a classic negation, but in reality, it is a 'mediated negation' of a change; that is, it is the product of a function.

This change to which we allude is 'hidden,' is not apparent and also has characteristics of being "cumulative." The reason that it is "not seen" is that just as the contexture representing the evident change captured within its ambit, the ambit of the contextures that is related (11). Here is a contexture that captures the contents of both related classes (00). If V (11) represented the co-presence of the poles, ∇ (00) represents the co-absence of them (Figure 10).

Fig. 10. Transformation or hidden change



The null value (00 - decimal: 0) makes this new contexture: ∇, 'invisible' (See Appendix A). This is so because it captures in its own content, the content of the related contextures, leaving evidence of the process of displacement and avoiding the disappearance of O (10), as it would have happened in a classical negation.

As there must be coherence in the system, necessarily, a series of operations must be carried out to justify this mediated displacement and demonstrate why S (01) is reached in spite of such operations.

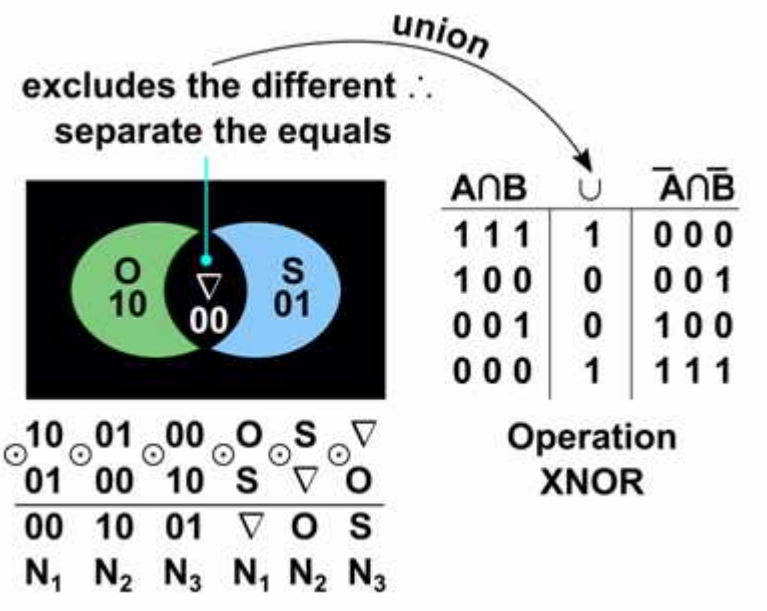
The intervention of a new contexture: ∇ (00), 'hidden,' produces a point of inflection in the surface structure, evident or discrete.

As shown in Figure 10, the intermediate step ∇ (00) between O (10) and V (11) (hidden) generates a pole opposite V (11); that is, its complement (and its opposite or negation). This complement is in every way, even in the fact of being the opposite of the apparent. Now V (11) is complete as a contexture since it acquires its content.

We can suppose, that the operation of composition that binds this new contexture ∇ to the already existing poles S and O, must be opposite to XOR.

This operation exists and is called *equivalence* or XNOR. This equivalence is based on the formal properties of propositional biconditionality (double implication) (we insist, here it is not a truth function). Its definition in our case would be: "An element belongs to the content of the intersection of two classes (A∩B), when it belongs to the content of both classes; and it will not belong to the content of the intersection, when it belongs only to the content of one of them ". In graphics and symbols, it is shown in Figure 11.

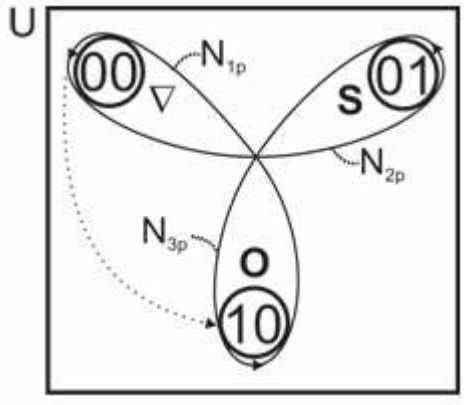
Fig. 11. Equivalence



If we apply the operation described the new contexture, we will have what is shown in the lower part of Figure 11. As in the superficial structure, the successive application of the suggested operation is equivalent to the successive negations, since it "cycles" through the different contextures. Applying once again the *equivalence* we arrive at the beginning of the cycle that in this case is of recursive or recurrent type and which we call "reflective."

A new triadic structure is thus proposed that adequately represents the “profound” aspect (hidden, not evident) of the reality of our universe. This structure cycles continuously (Figure 12).

Fig. 12. Profound cycle



References: N_{np}: profound negations

Figure 12 shows that the appearance of 00 means a 'turning point' (according to the geometric sense of the term, it is when a curve changes direction). The surface structure cycles to the right and this deep structure goes to the left.

4.0 MEDIATED NEGATION

"In this new universe, a second negation is not an affirmation." Mediated negation is the ideal tool to logically represent subjectivity. This is possible because it behaves like a distributor of binary systems, which in turn, defines the reflective process, the exclusive patrimony of the subject (S). This definition is somewhat ambiguous, but we could rescue it if we say that mediated negation behaves as a heterarchical (See Appendix A) distribution of hierarchical systems.

To apply mediated negation, we must have a set of elements greater than two. Starting from a trivalued system, six reflective patterns can be proposed that represent the possible relationships between the subject (S) and object (O) mediated by a transformation.

As we already said, each contexture (or unitary binary element) is composed of 'order' and 'disorder' or both. (Figure 13).

Fig. 13. Assignments table

order	disorder	
0	1 →	S(1)
1	0 →	O(2)
1	1 →	V(3)

decimal equivalent

According to Fig. 13, S and O are opposite elements (one is the negation of the other), as established by the Boolean (bivalued) logic.

Mediated negation distributes this tri-valued system generating a reflective and conservative loop, according to the following norm (Figure 14).

Fig. 14. Mediated negation

1 → 2
3 → 1
2 → 3

It means that: the second (N_2) denial of 1 is 2; that the N_2 of 3 is 1, and that the N_2 of 2 is 3.

This produces an exchange (and not an annulment) between elements (contextures) that after three negations take us to the initial element, closing the cycle that in this case, is levorotatory (L_V) (Figure 15).

Fig. 15. Levorotatory (Lv) and dextrorotatory (Dx) cycles

Thus, the S and the O are related through the change V, which binarily has components of both equally (11) (decimal = 3) In Figure 15 is represented a dextrorotatory cycle, where, the regime of negations is as follows: 1 → 3 - 3 → 2 - 2 → 1). If in the previous figure we replace the decimal numbers by their ontological equivalents we have, in the levorotatory: SOV, OVS, VSO. Here, despite being a levorotatory cycle, the different patterns are obtained, practically, by making a shift to the right of the extreme left element. The opposite happens in the other cycle: SVO, OSV, VOS, where, in spite of being a dextrorotatory cycle, to obtain the different patterns we have to move to the left the extreme right element. All these successions, from the logical point of view, are obtained by applying, in pairs, an XOR.

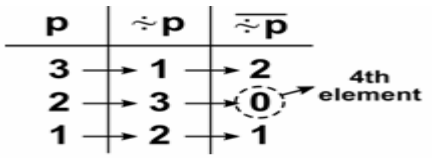
5.0 THE FOURTH ELEMENT

To constitute a true composite contexture (pattern of reality) 4 elements are needed. We provoke the 'generation' of the fourth element to form a tetravalent system. [A true system] This can be achieved if we apply the classical negation to a trivalent system affected (disturbed) by mediated negation. Now, in these circumstances, a binary negation does not have the same effect as that applied individually to a bivalent system. That is, it does not cancel it, but rather duplicates it since the non-correspondence of values leaves the third value without corresponding denied. Or in another way, it produces the appearance of another element that represents the 'absence of relation' between S and O. If V, by relating (interrelating) S and O represents a certain “organization”, ∇ (binary = 00 - decimal = 0) accounts for certain “disorganization”, which in reality represents a potential capacity for reorganization of the system (self-organization).

This new value does not take place in a trinary system. Therefore, it forces to generate another trinary loop that joins the previous one, although with particular characteristics. It is reflexive because it is structured by a mediated negation, but also cycles in the opposite direction and although the constitutive elements are the same as the original ones: S and O, they are not joined by a binary context that co-participates (co-presence). But it dissociates or releases them (co-absence), predicting the sequence (in jumps) of the complete system (6 valences) (distributed binary systems). Therefore, the 'displacement' of one element to another is carried out, not abruptly, but diffused (continuous). The opposing directions of rotation of these two cycles explain the isomeric complementarity they possess.

The following table establishes the steps specified above (Table II).

Table 2. Mediated negation – 4th element



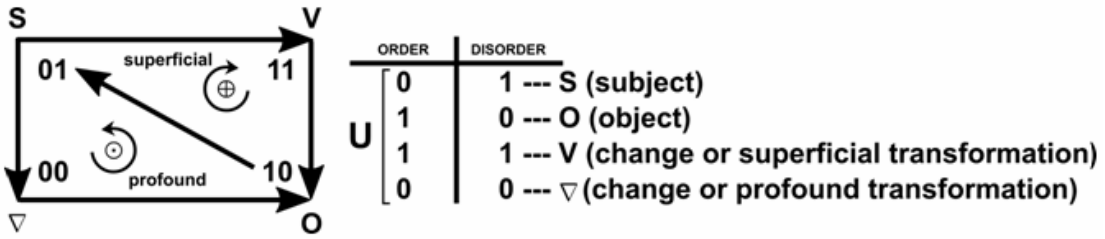
References: ÷: mediated negation - ¯: classic negation

We see, in Table 2, where the fourth value comes from. We must bear in mind that co-presence is a sign of heterarchy, not of hierarchy or transitivity, which makes possible co-ordination (organization), and therefore, self-reflection. This also allows the assembly of hierarchical (binary) (subordinate) and heterarchical (n-ary) (coordinates) systems.

6.0 UNIVERSAL AUTONOMOUS PATTERN (PAU)

If we assemble the two structures described in this universe that we have built, we will obtain a true system represented by an algebraic structure similar to that proposed by Boole, but with the significant difference that in our case, the "universe" represents a "permutation group " (See Appendix A) as those defined by Galois in 1832. This last characteristic allows the structure proposed by the TL to be dynamic. That is, have evolution as time goes by, propitiated by the functions (relationships) that define it. This is why the logic that describes and explains this evolution is called "Transcurssive Logic." (Figure 16)

Fig. 16. PAU



References: ⊕: XOR - ⊙: Equivalence or XNOR - U: Universe

The previous scheme shows a "universe" represented by a complex system, the result of the assembly of evident and "hidden" manifestations. We have given this unit the name PAU (Universal Autonomous Pattern). In it, both its structure and its functions (relations) are expressed, that is, the "functional geometry" that aims to represent the smallest evidence of reality that a subject can conceive.

The PAU is, structurally speaking, a "Galois group," but from the functional point of view it is a "Galois connection." In 1832, Galois discovered the group he defines as a set of elements gathered by a composition operation (in our case ⊕) that applied to some elements of the set, gives us an element of the set. There is a neutral element in this set which, together with another of the same set, does not modify it (in our case ∇). There is an inverse operation that, when it is used together with the composition operation, gives the neutral element (in our case ⊙). Finally, all the compositions are associative or independent of their grouping. These characteristics make this group a prototype of structure, given that it does not arise from the constitutive elements themselves, but from the permutative interrelationships between them. (Salatino, 2017, p 206).

A bivalued logic, like Boole's, is isomorphic. This isomorphism arises from the principle of the excluded third. The duality of conjunction and disjunction and the fact that in classical logic the dividing line between designation and non-designation coincides with the distinction between affirmation and negation (Ibidem, p.64).

In TL there is no such duality, because there is a "splice", a Galois connection (mathematically speaking), where disjunction and conjunction constitute the mediating opposition between another opposition: the two initial sets: S and O. This allows establishing a relationship between the objective (the known) and the subjective (the unknown), suggesting that the subjective should also correspond, in some way, to the real facts (Salatino, 2009). Nor is respected the principle of the excluded third, that which defines the hierarchy of binary systems, the heritage of

the monocontextural content. In a polycontextural logic such as TL, what links the different continents (or ontological niches - Salatino, 2008) is a heterárquica relation. Then, we could say that the TL represents a "heterarchical distribution of hierarchical or binary systems."

The bivalued logic is traditionally considered as the doctrine of the "laws of thought" (Boole, 1854). These laws are supposed to regulate the activity of a computational system or subject (S) which maps their environment. They refer, by designation, to an external world, and by self-reference, to themselves. In other words, the classical bivalent system represents two ontological places to which we can call, conventionally, "thought" and "being." (Günther, 1967) The above constitutes a double inconsistency. On the one hand, a binary system has room for a single ontological place, for some reason Günther called it "monocontextural."

On the other hand, a bivalued system like Boole's can only represent the object or the subject and one at a time. Furthermore, "thought" and "being" is not and can never be ontological or real places, not at least, from the subjective point of view (Salatino, 2009).

7.0 EXPANSION OF A FUNCTION

Returning to Boole's algebraic interpretation, we see that if x and y represented two different classes, $x + y$ represented a class that simultaneously contained all the individuals of x and y. The previous situation corresponds to the union of the "class logic." On the other hand, Boole interpreted the difference between classes $x - y$ as the class formed by all individuals of class x and none of class y. Which is equivalent to the intersection of "class logic." From all the above, the following pair of equalities arises:

$$x + (1 - x) = 1 \qquad \textbf{(1)} \text{ (union)}$$
$$x \cdot (1 - x) = 0 \qquad \textbf{(2)} \text{ (intersection)}$$

Equation **(1)** tells us about the totality of individuals in a universe (those that belong to class **x** and those that do not, its complement, whose sum gives the unity).

Equation **(2)** expresses the Aristotelian "principle of non-contradiction," mathematically. (From Vado Virseda, 2017, page 56)

Boole not only included addition and subtraction between symbols in his algebra, but also division, which plays an important role in this method. The solution that, for example, gave to the equation $xw = y$, was $w = y / x$. Without clarifying what this operation means in logic, he interprets it by introducing the "expansion (or development) of a function."

The method of "expansion" works in the following way: if $f(x)$ is an algebraic expression, its expansion is given by:

$$f(x) = f(1)x + f(0)(1 - x) \qquad (3)$$

The previous identity is established assuming the general form: $f(x) = ax + b(1 - x)$ (Bear in mind that $(1 - x) = y$). Then, a and b are determined by setting $x = 1$, $x' = 0$, $y = 1$ and $y' = 0$. For an expression with two variables, we have:

$$f(x, y) = f(1,1)\, xy + f(1,0)\, xy' + f(0,1)\, x'y + f(0,0)\, x'y' \qquad (4)$$

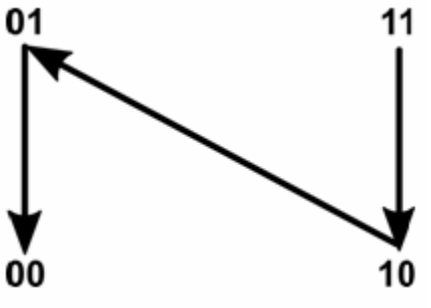
Then, if $f(x, y) = y / x$, then:

$$y / x = 1/1.\, xy + 1/0.\, xy' + 0/1.\, x'y + 0/0.\, x'y' \qquad (5)$$

The argument of Boole to equal a function with its expansion is at least defective because it assumes (without justifying it) that any function applied to its variables is linear (Nahin, 2013, p 69).

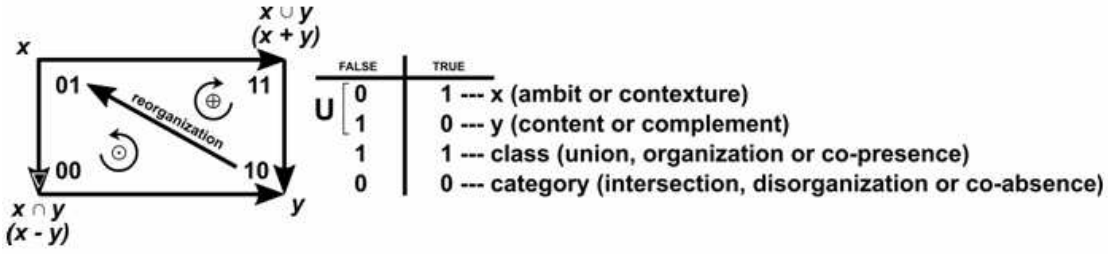
As we can see, the incompatibility between the Boolean algebra and the TL is multiple. In the first place, it strictly respects the basic principles of Aristotelian logic, something that does not happen in TL. Second, the use of the "expansion of a function" while describing, in some way, the "classes" that inhabit the universe analyzed does not succeed in establishing, completely, the relationships that are generated between them **(4)**, nor does it says about the mechanism that allows one to "move" from one to another to scrutinize said universe (Figure 17).

Fig. 17. Expansion of a function



The PAU in Figure 18 clearly shows that the similarities between Boolean algebra and TL are nothing more than that, mere similarities.

Fig. 18.The logic within the logic



The fundamental nucleus of the TL (PAU) has a structure that consists as if it were a class (as a set of objects), a scope (or contexture) x, and a compliment (or content) y. On the other hand, from the "union by the differences" of x and y (x ∪ y) and its opposite, the "separation by the similarities" of x and y (x ∩ y).

From the functional point of view, this nucleus determines x and y, the simultaneous presence of what distinguishes them (x + y or disjunction), and the simultaneous absence of what they have in common (x • y or conjunction). In this way, they form a "splice" of the union (∪) of what differentiates them, with the separation (∩) of what equals them, that is, that both belong to the set of real elements, or that they exist in the universe considered.

In this way the transformations that bind x and y that complete the PAU is defined. The "apparent or superficial transformation" (organization or co-presence) that we call "class," and the "hidden or deep transformation" (disorganization or co-absence) that we will call "category." It is important to clarify the terms used. The *transcurssive category* is neither the Aristotelian form of thought that reproduces something that occurs in objective reality, nor the pure concepts of the Kantian understanding, nor any of the three ontological categories of Peirce, nor those of Hegel, but the basis of the "sense" of the interrelations that keep the main actors in the subjective reality of a given universe (**U**). On the other hand, the *transcurssive class* is not a set of things that share some property, but on the contrary, it is the union of different objects that differ in some aspect.

Finally, what is obtained in the superficial level of the PAU (organization: union by the differences = 11) is projected in the profound level, (disorganization: separation by the similarities = 00) using the "inflection point" that means the appearance of the "fourth element." This projection

has as a goal to disorganize what has been obtained at a superficial level, and then reorganize it according to the requirements of the previous operation. Take into account that the surface level is what registers the "demands" of the environment, its "organization." Once the reorganization process has taken place at a deep level, what is obtained is again projected onto the surface, by the same 'channel' of the inflection point but traveled in the opposite direction. This last projection places the system at a new level of equilibrium with the environment, but now with a greater complexity that has allowed it to adapt to environmental demands.

8.0 CONCLUSIONS

In the analysis of basic principles on which Boole's algebra is based, we have discovered that some of the aspects of reality, that are revealed when we approach it from the subjective, are hidden between its values of truth and functions. That is, there is an “implicit logic” underlying the Boolean binary proposal, a logic that we have called 'transcurssive' because it leaves evidence of a certain evolution over time, of what affects an observer.

Among the findings we have to highlight: a) the existence of a complex system based, not on its constituent elements and a specific purpose, but on the interrelations that link its components. b) a systemic complexity that enables an adaptive dynamic response in front of the demands (inputs). c) the possibility of analyzing through the discovered structure, the relational situation of several binary systems, simultaneously (heterarchical distribution of hierarchical systems). d) the functional non-dependence of the structure concerning the observer (measurement process), as it is the case with any situation that is objectively addressed, and e) the advantage of being able to consider situations where more than two states are at stake, even if they are exclusive.

From the transcurssive perspective, an interesting panorama opens up of possible applications of this way of observing reality.

"From where, apparently there was nothing, the Transcurssive Logic arises."

REFERENCES

Bochenski, J. M. (1981). *The General Sense and Character of Modern Logic.* En 'Modern Logic – A Survey. Historical, Philosophical, and Mathematical Aspects of Modern Logic and its Applications. Edited by Evandro Agazzi. Dordrecht, Holland, D. Reidel Publishing Company.

Boole, G. (1847). *The Mathematical Analysis of Logic*. Cambridge, Macmillan, Barclay & Macmillan.

Boole, G. (1854). *An Investigation of the Laws of Thought. On which are founded the mathematical theories of logic and probabilities*. Cambridge, Macmillan and Co.

Del Vado Virseda, R. (2017). *Boole. El creador del algebra de la lógica*. Serie: Genios de las matemáticas. Barcelona, RBA Coleccionables, S. A.

Euler, L. (1768). *Lettres a une princesse d'Allemagne. Sur divers sujets de Physique & de Philosophie*. Tome Second. Saint Petersbourg, L'Academie Impériale des Sciences.

Günther, G. (1967). "Time, Timeless Logic and Self-Referential Systems" – *Ann. N. Y. Acad. Sci*; **138**, pp. 397-406.

Günther, G. (1972). *Negation and Contexture*, en: www.vordenker.de (Edición: Febrero 2004), J. Paul (Ed.). Manuscrito no publicado fechado 21/8/1972.

Hegel, G. W. F. (1812/1816 - 2011). *Ciencia de la Lógica* –Madrid, Abada Editores – UAM Ediciones.

Hegel, G. W. F. (1807 – 1985). *Fenomenología del espíritu*. Madrid, Fondo de Cultura Económica.

McCulloch, W. (1945). "A Heterarchy of Values Determined by the Topology of Nervous Nets." *Bull. Math. Biophys*; **7**, pp. 89-93.

Morin, E. (1986). *El método. La naturaleza de la naturaleza*. Madrid, Cátedra.

Nahin, P. J. (2013). *The Logician and the Engineer. How George Boole and Claude Shannon created the information age*. Princeton, NJ, Princeton University Press.

Noether, Emmy (1908), «*Über die Bildung des Formensystems der ternären biquadratischen Form* [Sobre sistemas completos de invariantes para formas ternarias biquadráticas] », *Journal für die reine und angewandte Mathematik* 134: 23- 90. [Tesis Doctoral]

Noether, E. (1918). *Invariante Variationsprobleme*, [Problema de variaciones invariantes] Nachr. d. König. Gesellsch. d. Wiss.zu Göttingen, Math-phys. Klasse, s. 235-257

Peirce, Ch. S. (1958). *The Collected Papers.* Vols. I-VI ed. Charles Hartshorne and Paul Weiss (Cambridge, MA: Harvard University Press, 1931-1935), Vols. VII-VIII ed. Arthur W. Burks (Cambridge, MA: Harvard University Press) (CP)

Piaget, J. (1985). *El estructuralismo*, Buenos Aires, Hyspamérica.

Salatino, D. R. (2008). *Realidad, lenguaje natural y una lógica alternativa*. Anales de Lingüística – Universidad Nacional de Cuyo – Facultad de Filosofía y Letras – Instituto de Lingüística – Centro de Estudios Lingüísticos (Tomo XXVII-XXVIII-XXIX: 2005-2006-2007): 75-106. Mendoza, Argentina: Editorial FFL. ISSN: 0325-3597.

Salatino, D. R. (2009). *Semiótica de los sistemas reale*s – Tesis Doctoral en Letras – Facultad de Filosofía y Letras – Universidad Nacional de Cuyo - Mendoza, Argentina.

Salatino, D. R. (2017). *Tratado de Lógica Transcursiva. El origen evolutivo del sentido en la realidad subjetiva*. Mendoza, Argentina, Primera autoedición. ISBN: 978-987-42-5099-5.

APPENDIX A

Class: Set of elements that have some property in common.

Discontinuous structure: It goes from one contexture to another by successive negations (at one time, all or nothing, 0 or 1). For this reason, the superficial structure is considered discrete or discontinuous.

Domain: Are the elements of the scope that satisfy a given function.

Double negation: ~~p = p; ~01 → 10; ~10 → 01.

Galois Group: As we have already described in other works, here we will only list the basic properties of these groups. These groups must have: a) a composition operation; b) an operation opposite to that of composition; c) comply with the law of closure or closing; d) possess a neutral element; e) possess reverse elements; f) comply with the associative property; and g) comply with the law of the closure or closing of the conjugate.

Heterarchy: Refers to the situation of interdependence that must exist between different levels or subsystems in which different processes are developed simultaneously.

"Invisible" contexture: This situation, in the class logic, is characterized as a null scope and universal content. Or what is the same, a null class for logical reasons, since there are no elements that belong to its scope; all belong to its content. Here co-absence does not mean non-existence, which also supposes absence, the impossibility of presence, but represents the functional value of co-presence.

Laws of classical logic: The proposed structure does not follow the laws of classical logic, although the operations ~(10▪~01) and (01+~01) represent principles or logical laws.

Ordered pairs: Thus, the ordered pair <0,1> in this order satisfies the relation 'tendency to go towards disorder' and the ordered pair <1,0>: 'tendency to go towards order'; both relations raised in U.

Scope: That constituted by the elements of which a function is predicated.

Traditional negation: In this negation, what is done is to deny only the contexture A (01), with which it is canceled (disappears), transforming itself into the contexture B (10).

International Journal of Research & Methodology in Social Science
Vol. 5, No. 1, p.101 (Jan. – Mar. 2019). ISSN 2415-0371 (online)
www.socialsciencepublication.com; DOI: 10.5281/zenodo.2667563

Minimum Sample Size Calculation Using Cumulative Distribution Function

Louangrath. P.I. ★ & Sutanapong, Chanoknath★★

About the author

★Louangrath, P.I. is an Assistant Professor in Business Administration at Bangkok University, Bangkok, Thailand. For correspondence, he could be reached by email at: Lecturepedia@gmail.com
★★ Sutanapong, Chanoknath is an independent researcher. She may be reached by email at: chanoknath.sutanapong@gmail.co

ABSTRACT

Minimum sample size is a requirement in most experimental designs. Research in social science requires minimum sample size calculation in order to support the claim that the sample represents the population. If the sample does not adequately represent the population, generalizability could not be achieved. In this study, we present a minimum sample size calculation method by using the cumulative distribution function of the normal distribution. Since most quantitative data in social science research employ surveys with responses in the form of Likert or non-Likert scales, the CDF of the normal distribution curve is an appropriate tool for sample size determination. We use binary data in a form of (0,1), and continuous data, in a form of quantitative non-Likert (0,1,2,3), and Likert (1,2,3,4,5), (1,2,3,4,5,6,7) and (1,2,3,4,5,6,7,8,9,10) scales as the bases for our modeling. We used Monte Carlo simulation to determine the number of repetition for each scale to achieve normality. The minimum sample size was determined by taking the natural log of the Monte Carlo repetition multiplied by *pi*. We found that in all cases, the minimum sample size is about 30 where we maintain the confidence interval at 95%. For non-parametric case, the new sample size calculation method may be used for discrete and continuous data. For parametric modeling, we employed the entropy function for common distribution as the basis for sample size determination. This proposed sample size determination method is a contribution to the field because it served as a unified method for all data types and is a practical tool in research methodology.

Keywords: Cumulative distribution function (CDF), Likert scale, normal distribution, sample size.

JEL Code: C02, C12, C15, C65, C85

CITATION:
Louangrath, P.I. and Sutanapong, Chanoknath (2019). "Minimum sample size calculation using cumulative distribution function." *Inter. J. Res. Methodol. Soc. Sci.*, Vol., 5, No. 1: pp. 100-113. (Jan. – Mar. 2019); ISSN: 2415-0371; DOI: 10.5281/zenodo.2667496

1.0 INTRODUCTION

The purpose of this paper is to provide a new method for calculating sample size based on the cumulative distribution function (CDF) of normally distributed data. We defined data as the quantitative scale used in the survey commonly employed in social science research. Data could generally be categorized into two types based on their distributions, namely discrete and continuous data. Demographic data may be classified as discrete data. Response scales in a form of Likert scale, such as (1,2,3,4,5), (1,2,3,4,5,6,7,), and (1,2,3,4,5,6,7,8,9,10) or non-Likert quantitative scale, such as (0,1,2,3), may be analyzed under continuous probability. This paper asserts that survey employing any of the aforementioned scale types may be analyzed by the CDF of a normal distribution.

Under Monte Carlo simulation, we can estimate the number of repetitions in order to achieve normality under the law of large number. For quantitative data, we expect the data to achieve normal distribution according to:

$$f(x \mid \mu, \sigma^2) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2} \right) \tag{1}$$

For binary or discrete data, we expect to achieve normal distribution under the deMoivre-Laplace Theorem under the following condition:

$$\lim_{n\to\infty} \Pr\left(\frac{X - np}{\sqrt{npq}} \right) \geq Z \tag{2}$$

where X = total success of the category of interest, n = number of observation, $p = (s+1\_/(n+2)$, and Z = critical value whose corresponding percentage probability may be found in the Z table. We are aware that certain discrete data, despite the increase in the number of observations will remain discrete or binary. Such exceptional case would be tested and treated separately and would not fall within the generalized case cover in this paper. If the data is not normally distributed, as we observed in the later part of this paper, we propose to use the entropy function for each distribution to augment our sample size equation in order to determine the minimum sample size for each case. We intend the proposed sample size determination method to have practical application in all cases whether the data is discrete or continuous, or whether the investigator is using parametric or non-parametric method in the investigation.

The motivation for this paper comes from the gap in the literature in sample size calculation based on response space. Most literature discussed sample size calculation in the context of the relationship between sample and population of respondents or participants. In this paper, we focus on the scale of the response used in the survey as the probability space. One researcher wrote that:

> "The estimation of the minimum sample size required for any study is not a single unique method, but the concepts underlying most methods are similar. The determination of the sample size is critical in planning clinical research because this is usually the most important factor determining the time and funding to perform the experiment." (Gogtay, 2010).

We treat this assertion as logical, but not practical because it lacks certainty. This uncertainty was shared by Israel who wrote that sample size determination is influenced by the "purpose of the study, population size, the risk of selecting a "bad" sample, and the allowable sampling error." (Israel, 1992). The intent of this paper is to look for a unified method to calculate sample size that would overcome the limitations saw by Israel and Gotay.

The National Institute of Science and Technology (NIST) in the US proposed a more definite sample size calculation method based on sample-population proportion. According to NIST, sample size is a proportion of the population; that proportion could fairly represent the population at a specified level of precision defined as:

$$\Pr\left(\left|\hat{p}-P\right|\geq\sigma\right)=\alpha \qquad (2)$$

where $\hat{p}$ = estimated proportion; P = unknown population parameter; σ = specified precision of the estimate; α = probability value. The sample size of the approximately normally distributed population is:

$$n=Z_a^2\left(\frac{PQ}{\sigma^2}\right) \qquad (3)$$

where Z is a critical value at a; p = probability of the current process determined by $p=(s+1)/(k+2)$ and $q=1-p$. We found this method of sample size calculation limited in application and unstable in outcome because it could only be used for binary data; hence, the presence of P and Q in the equation. In addition, if P and Q is used, the variance should have also come from the binary data set, i.e. variance should have been written as $\sqrt{nPQ}$, not σ^2. A more efficient sample size formula should be able to accommodate both discrete and continuous data. One objective of this paper is to address this inadequacy.

Since the function of the sample is to represent the population, the precision of the equality between the sample and population may be written as:

$$\Pr\left(\left\|\frac{\bar{y}-\mu}{\mu}\right\|\geq\sigma\right)=\alpha \qquad (4)$$

where μ is the unknown population mean and $\bar{y}$ is the sample mean. The sample size is determined by:

$$n\approx\frac{Z_a^2\sigma^2}{\sigma^2\mu^2} \qquad (5)$$

where σ^2 is population variance. NIST's approach to determine sample size is based on proportional representation. The proportion is the ratio between the sample and the population.

In this paper, we assert that where response scale is used in survey, the observed value from the sample and the estimated value for the population should be confined to the probability space of the scale itself. No matter how large the population, the answer to the survey would fall within the value range of the scale. For example, if the Likert scale is used, for a scale of (1,2,3,4,5), the value of the sample and the population will fall between 1 and 5, similarly for a Likert scale of (1,2,3,4,5,6,7), the sample and population values would fall within the range of 1 and 7. Thus, in this paper, we propose the use of the probability space of the scale to estimate sample size for the studies using quantitative scale as response choice.

The intended contribution of this paper is to provide a practical tool for calculating sample size to researchers in social science. By so doing, we hope to dispel many questions about how many sample elements must be taken in a given research. If the research employs a survey with

response scales that are classified as quantitative data, we assert that under the calculation method proposed by this paper, the minimum sample size is about 30.

The scope of this paper is confined to sample size calculation for quantitative research in social science. In qualitative method, the content of the research generally is tainted with subjectivity of the investigator; as for sample size determination, it is also unsettled and is highly influenced by the investigator's subjectivity (Sandelowski, 1995). The lack of systematic guidance in qualitative research is evidenced by the practice of keep adding more participants until a saturation point is reached (Glaser, 1965). Although saturation point has been studied, definitive guidance on sample size determination in qualitative research remains unclear (Francis *et al.*, 2010; Guest *et al.*, 2006; and Wright *et al.*, 2011). Only suggestions on how many samples should be taken, but there is no definitive method for calculating sample size for qualitative research (Onwuegbuzie and Leech, 2007; Fugard and Pott, 2015). For instance, it has been suggested that samples should be collected to the point where a "theme" may be observed and a "theme analysis" may be used (Galvin, 2015). Due this lack of guidance in the research method itself, qualitative research is outside the scope of this paper. Nevertheless, despite such inadequacy in qualitative research, so long as the qualitative data could be coded in binary data, the proposed sample size determination method in this paper could also be useful for qualitative research. To that end, this is an additional contribution of our proposed sample size determination method because it eliminates the uncertainty in sample size calculation in qualitative research.

2.0 LITERATURE REVIEW

There are several scenarios where sample size becomes an issue in research in social science, (i) types of data, i.e. whether the data is time series or non-time dependent, and (ii) parametric of non-parametric testing. When dealing with the type of data, we are face with data that may be classified according to their type of distribution, such as discrete or continuous. Discrete distribution describes data that came from binary or categorical domain which are coded 1 = yes and 0 = no. Continuous data deals with quantitative scale which are commonly used in survey; for instance, (0,1,2,3) or (1,2,3,4,5) are common quantitative scales used in social science research survey.

The second situation where minimum sample size plays a role in assessing the adequacy of research methodology may deal with parametric and non-parametric cases. In parametric modeling, we are asking: "what is the minimum sample required for testing the proposed model?" A model is a mathematical function, also known as the predictive function. Minimum sample size in parametric studies allows the researcher to propose a reliable predictive function for a given construct or group of constructs to explain a given phenomenon. How reliable and valid that proposed predictive function may depend on whether in constructing such function, did the research use adequate sample. For instance, it has been suggested that in multiple regression modeling, each variable should have at least ten observations. Thus, a multiple regression function with three variables, x1, x2, and x3, should have at least 30 sample counts.

2.1 Sample size for non-parametric case

Conventional sample size determination may be divided into two scenarios: finite population and non-finite population. In finite population, the population size is known. Assuming that the population is large enough and normally distributed, sample size may be obtained through the Yamane equation:

$$n = \frac{N}{1 + N(e^2)} \tag{6}$$

where N = population size and e is the error level (Yamane, 1967; p. 886). We found this method of sample size calculation limited in application because in order to use the Yamane equation, the

population size must be known. This requirement is not practicable because in most cases in real life, the population size is either unknown or unstable. Even if the population is known, at 95% confidence interval, the Yamane equation tends to produce a fixed sample size at about 400. This number may be too large and costly; thus, making it unpractical. We also note that the Yamane method had been misunderstood and misused to mean that sample size in all cases is 400. This misunderstanding comes from the misuse of the standard error formula: $SE = \sigma / \sqrt{n}$ by allowing $\sigma = 1$, $SE = 0.05$ and solve for n. The answer is $n = 400$. We reject this approach to sample size calculations as erroneous and does not conform to the function and purpose of sample size. The assumption that $\sigma = 1$ is erroneous because such an assumption is may be true when the data is normally distributed. The setting of the error to 0.05 is a error is the misuse of misunderstanding of the standard *beta* where the error level is fixed at 0.05 for 0.95 confidence interval. However, the use of $SE = 0.05$ in this case has no empirical support. Both the assumptions of $\sigma = 1$ and $SE = 0.05$ are not supported by the data in each case.

A second scenario involved unknown population size. In the non-finite population case, a test sample must be taken to learn the approximate variance of the population. For non-finite population, Smith provides the following formula:

$$n = \frac{Z^2 \sigma^2}{e^2} \tag{7}$$

where Z is the critical value, sigma is the estimated standard deviation, and e is the error level (Smith, 1983). We found this method of sample size calculation limited in application and unstable in outcome because in order to use equation (7), a test sample must be used. Different sizes of the test sample change the outcome of n. For example, test sample sizes 10, 20 or 30 would have different required sample size n. These differences are evidence to prove that this sample size calculation method is not reliable. Reliability is defined as consistency in outcome. Equation (7) fails this requisite.

The formula given by Yamane and Smith may be classified as general approaches to sample size determination based on population size (Yamane's approach) and distribution of the test sample (Smith's approach). We reviewed the literature in more specific cases on the basis of data type, i.e. continuous or discrete data. The literature for the general case based on population size, and the specific cases based on data types, provides us a context for our introduction of sample size calculation method based on response space or instrument scale-based approach.

2.1 Sample size determination for categorical data

Sample size determination of categorical data or binary data for non-finite population was discussed by Cochran (1963: 75) who provides the following formula:

$$n = \frac{Z^2 PQ}{e^2} \tag{8}$$

This formulation is limited to binary data as indicated by p and q where $p = (s+1)/(n+2)$ and $q = 1 - p$.

For categorical data, minimum sample size may also be determined by two proportions of the categorical data:

$$n = \frac{2\left(Z_\alpha + Z_\beta\right)^2}{d^2} \tag{9}$$

where $d = (p_1 - p_2)\sqrt{p(-1p)}$ and $p = (p_1 + p_2)/2$.

The use of normal distribution as the reference or ideal condition to determine sample size is well documented (Devane and *et al.*, 2004). The element of sample size determination include the type of data and it distribution (Julios, 2004). While data distribution is not under the control of the researcher, certain terms are under the researcher's control. These uncontrollable factors include: (i) detectable effect size; (ii) probability of falsely rejecting the null hypothesis (alpha error); (iii) probability of rejecting false null hypothesis (beta error); and (iv) estimated standard deviation (sigma) (Karlson *et al.*, 2003). So what?

Sample size determination in social science allows the studies to make a generalization about the population through inference. However, in medical science sample size may allow the researcher to verify treatment effect. Noordzij *et al.* (2010) wrote that: "The main aim of a sample size calculation is to determine the number of participants needed to detect a clinically relevant treatment effect." Four components are considered when calculating sample size: (i) type I error; (ii) power; (iii) minimal clinically relevant difference; and (iv) variability (Noordzij, 2010). For medical science, Noodzij provides two methods for sample size determination where the data is continuous and discrete.

For discrete data, the formula was given:

$$n = \frac{\left|(a+b)^2(p_1q_1 + p_2q_2)\right|}{x^2} \qquad (10)$$

n = sample size of each group; p_1 = proportion of subjects with factor of interest in group 1; q_1 = proportion of subjects without factor of interest in group 1; p_2 = proportion of subjects with factor of interest in group 2; q_2 = proportion of subjects without factor of interest in group 2 $(1 - p_2)$; x = the difference the investigator wishes to detect; a = multiplier for alpha = 0.05; and b = multiplier for power = 0.80.

We found these two methods (equations 8, 9 and 10) of sample size calculation limited in application because the presence of P and Q allows the formula to be used only with discrete or binary data. In order to be efficient, the sample size formula must be able to accommodate both discrete and continuous data.

2.2 Sample size determination for continuous data

Gotay discussed two scenarios involving two means comparison in continuous and discrete data. In continuous data, for means comparison, the formula was given:

$$n = \frac{(Z_a + Z_b)^2\sigma^2}{d^2} \qquad (11)$$

where d = effect size. The effect size d of continuous data is given by Cohen (Cohen, 1988; p. 67):

$$d = \frac{\bar{x}_1 - \bar{x}_2}{s} = \frac{\mu_1 - \mu_2}{s} \qquad (12)$$

The pooled standard deviation (s) is obtained by: $s = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$.

For two group comparison with continuous data, the formula for calculating sample size is given by:

$$n = \frac{2\left[(a+b)^2\sigma^2\right]}{(\mu_1-\mu_2)^2} \tag{13}$$

n = sample size of each group; μ_1 = population mean of treatment group 1; μ_2 = population mean of treatment group 2; $\mu_1 - \mu_2$ = the difference that the investigator wants to detect; σ^2 = population variance; a = multiplier for alpha = 0.05; and b = multiplier for power = 0.80.

In these two methods (equations 12 and 13), we found the same inadequacy as we observed in equations 8, 9 and 10 , because they could only be used for continuous data and cannot accommodate binary data.

In this paper, we present a new method for calculating sample size based on the probability space in the survey's scale using the cumulative distribution function (CDF) as the basis. We note that discrete data does not have CDF, but the mass distribution function (MDF); nevertheless, the data set of (1,0) is converted to its continuous equivalence by using the DeMoivre-Laplace Theorem in order to obtain unified approach in sample size determination. The new sample size calculation can accommodate both discrete and continuous data of the response space. Whether the response space comes from binary data (1,0) or continuous data in a form of Likert or non-Likert scales, the new sample size calculation method could accommodate both types of data because we use the probability of the response element or component as the basis for sample size calculation. In all other sample size calculation methods hitherto, population parameter estimate was used as the building block. There is a lack of standard formula for sample size calculation because different types of modeling require different types of parameter estimation. The new method introduce in this paper overcomes this weakness of the traditional method. To the extent that the new method is an improvement over those found in the literature, the new method for sample size calculation is a contribution to the field.

2.3 Sample size determination for parametric modeling

Parametric modeling involves the use of predictive function to explain the data. The predictive function may depend on the type of the distribution of the data. In this paper, we present five common distribution found in social science research where psychometric scales are used in opinion surveys. These common distributions are: (i) normal, (ii) logistic, (iii) beta, (iv) gamma, and (v) Weibull distributions. For each distribution, we use the entropy as the threshold for which sample size determination may be determined. Entropy is defined as the function explaining the point at which information break down commences, i.e. the point where the stability of the distribution starts to deteriorate.

2.3.1 Normal distribution and its entropy function

When the data is obtained through quantitative scale, ideally if the data behaves according to the law of large number, the data would manifest normal distribution where the plot of the distribution curve resembles perfect bell shape. The PDF and CDF of the normal distribution are given by:

$$PDF(N) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-((x-\mu)^2)/2\sigma^2} \tag{14}$$

$$CDF(N) = \frac{1}{2}\left[1 - erf\left(\frac{x-\mu}{\sigma\sqrt{2}}\right)\right] \tag{15}$$

Alternatively, the CDF for the normal distribution may be obtain by the percentage probability function:

$$F(Z) = \frac{1}{1+\exp\left(-\sqrt{\pi}\left(\beta_1 Z^5 + \beta_2 Z^3 + \beta_3 Z\right)\right)} \quad (16)$$

where $Z = (x - \bar{x})/s$, $\beta_1 = 0.0004406$, $\beta_2 = 0.0418198$, and $\beta_3 = 0.90000000$. The entropy function for the normal distribution is given as:

$$E(N) = \frac{1}{2}\log\left(2\pi e\sigma^2\right) \quad (17)$$

2.3.2 Logistic distribution and its entropy function

In many instances, psychometric scales used in social science research aim to measure the pattern of emotion, judgment, loyalty or other forms of mental outlook, the data does not behave in a straight line as we might expect in normal distribution case. In many instances, these types of psychometric data will manifest a sigmoid pattern which may be captured by a logistic function. The data with this sigmoid pattern may be explained by logistic distribution. The PDF and CDF of logistic function are given by:

$$PDF(\log) = \frac{e^{-z}}{s(1-e^{-z})} \quad (18)$$

where $z = (x - \mu)/s$. The point-by-point percentage probability of x is determined by the CDF. The CDF of the logistic distribution is obtained by:

$$CDF(\log) = \frac{1}{1+e^{-z}} \quad (19)$$

The point at which the information of the logistic distribution starts to under go instability or dissipation is called entropy. Information entropy for the logistic distribution is given by:

$$E(\log) = \ln s + 2 \quad (20)$$

2.3.3 Beta distribution and its entropy function

When the data is negatively skewed, the distribution of the data may be classified as beta distribution. Negatively skewed data may provide information about the gravitation or change which the population is moving away from the mean to the upper range of the tail of the curve. In many instances, this change may signify an improvement or a pattern of adoption of new technology. The PDF and CDF of beta distributions are given by:

$$PDF(\beta) = \frac{X^{\alpha-1}(1-X)^{\beta-1}}{B(\alpha,\beta)} \quad (22)$$

where $B(\alpha,\beta) = \frac{\Gamma(\alpha)\Gamma(\beta)}{\Gamma(\alpha+\beta)}$. What is gamma ? what is a? what is b?

$$CDF(\beta) = I_x(\beta,\beta) \tag{23}$$

This is known as an incomplete beta function where $B(x;a,b) = \int_0^x t^{a-1}(1-t)dt$ for $x=1$ the incomplete beta function coincides with the complete beta function. The regularized incomplete beta function is obtained by: $I_x(a,b) = \frac{B(x;a,b)}{B(a,b)}$.

The entropy function where the information loss is observed for the beta distribution is obtained by:

$$E(\beta) = \ln B(\alpha,\beta) - (\alpha-)\psi(\alpha+\beta) \tag{24}$$

2.3.4 Gamma distribution and its entropy function

The opposite of beta distribution is the gamma distribution. In gamma distribution, the data is positively skewed. Positively skewed data in psychometric measurement may provide information that the population is lagging behind a certain change or is slow to adopt new idea or innovation. The right-side of the tail of the curve may indicate introduction of new ideas, innovation or people's opinion starts top erode from the old mean. The PDF and CDF of the gamma distribution function are give by:

$$PDF(\gamma) = \frac{1}{\Gamma(k)\theta^k} x^{k-1} e^{-x/\theta} \tag{25}$$

$$CDF(\gamma) = \frac{1}{\Gamma(k)} \gamma\left(k, \frac{x}{\theta}\right) \tag{26}$$

where $k > 0 = shape$, $\theta > 0 = scale$, and $\alpha > 0 = shape$; $\beta > 0 = rate$.

The significant erosion from the old mean may be indicated by the breaking down of information. This information breakdown may be indicated by entropy. The entropy as a measure of information loss for the gamma distribution is given by:

$$E(\gamma) = k + n\theta + \ln\Gamma(k) + (1-k)\psi(k) \tag{27}$$

In cases where predictive model was used, the distribution function for each data set in the modeling may be used f

Table 1. Sample size calculation for parametric modeling

Distribution Tye	Entropy	Sample size equation
Normal	$E(N) = \frac{1}{2}\log\left(2\pi e\sigma^2\right)$	$n_\phi = \ln(n)\pi$ $n_{\phi*} = n_\phi(1+E)$ where n_ϕ is nonparametric sample size, $n_{\phi*}$ is parametric sample size, and E is the entropy function of the distribution.
Logistic	$E(\log) = \ln s + 2$	
Beta	$E(\beta) = \ln B(\alpha,\beta) - (\alpha-)\psi(\alpha+\beta)$	
Gamma	$E(\gamma) = k + n\theta + \ln\Gamma(k) + (1-k)\psi(k)$	

3.0 DATA AND M ETHODOLOGY

3.1 Data derived from content of response scale

The data used for calculating sample size is based on the component of the scale used in the survey. We assume that a good survey is one that employs a single scale throughout its survey. For instance, if a Likert scale (1,2,3,4,5) is used, all questions soliciting quantitative data in that survey would use only (1,2,3,4,5) for also questions. The characteristics of each scale type are reported in Table 1.

Table 2. Response scales and their characteristics

Scales	Type	$\overline{X} \pm S$	$\mu \pm \sigma$	Skew	Kurtosis
(1,0)	Discrete	0.50 ± 0.71	0.07 ± 0.37	-	-
(0,1,2,3)	Quantitative	1.50 ± 1.29	0.44 ± 1.28	0.00	-1.20
(1,2,3,4,5)	Likert	3.00 ± 1.58	1.84 ± 1.57	0.00	-1.20
(1,2,3,4,5,6,7)	Likert	4.00 ± 2.16	2.66 ± 2.15	0.00	-1.20
(1,2,3,4,5,6,7,8,9,10)	Likert	5.50 ± 3.03	3.93 ± 3.01	0.00	-1.20

The response scale is used as the observation set; however, the components used for purposes of calculating sample are the CDF of the scale elements. The CDF of each scale component reports the percentage probability of each component. These percentage probabilities are used to determine sample size.

With known CDF of each component of the scale, we then use Monte Carlo simulation to obtain the number of repetitions to have data points fill the probability space of a unit circle. In the final step, the sample size is obtained by multiplying the log number of Monte Carlo repetition by π. The rationale for taking the log of the number of repetition is to force fit the number of repetition into a unit circle. The rationale for using π comes from the ratio of the circumference to the diameter of the circle.

3.2 Proposed new method for minimum sample size calculation

Traditionally, power calculation is one indicator used in assessing the adequacy of sample size. Power is defined as the percentage probability of event defined by F(Z) as defined in by equation 16, *supra*. Power is the probability of not committing Type II error (failing to reject the null hypothesis despite the empirical evidence dictating otherwise). The probability of Type II error is $\beta = 1 - F(Z)$.

In this paper, we introduce a new way of calculating the power of the sample size through the use of probability space of the unit circle of the assumed normal distribution curve. We define power of the sample as the observed or empirical sample over the theoretical sample of the log number of Monte Carlo repetition (N) that would have fitted into the unit circle. This new power calculation may be obtained through the following steps:

Step 1: Determine the expected number of repetition ($\hat{N}$) for Monte Carlo simulation that would fit data points into a unit circle's probability space assuming that the data is normally distributed $N(0,1)$ with $E = 0.05$ for 95% confidence interval and $\sigma = 1.00$:

$$\hat{N} = \left(\frac{6\sigma}{E}\right)^2 \rightarrow LN(\hat{N}) \qquad (28)$$

The number 6 is used to represent 6 standard units of the sigma or standard deviation in the normal distribution curve. The error level (E) is the precision level determined by α or the

significance level in the distribution curve. The natural log value of the repetition ($\hat{N}$) is used because we need to descale the value to fit the unit circle. The expected sample size at various level of E is listed in Table 3. For our evaluation in this paper, we use $E = 0.05$ with the corresponding sample size of $n^* = 30.07$.

Step 2: Determine the empirical sample size by using the CDF of the scale as the basis:

$$n_\phi = \ln(N_O)\pi \tag{29}$$

where $N_{obs} = (3\sigma / E)^2$ with the inferential standard deviation σ calculated from $\{x_1, x_2, x_3\}$ with $x_1 = \max$, $x_2 = \min$, and $x_1 = (\max + \min)/2$, and $E_o = (\max - \min)/2)/50$.

Step 3: Power (Π) is determined by calculation the ratio of the empirical or test sample size (n_ϕ) to the theoretical sample size $(\hat{n})$ in step 1 by:

$$\Pi = 1 - \left(\frac{n_\phi - n^*}{n^*} \right) \tag{30}$$

where n_ϕ = sample size estimated by CDF of the scale components; $\hat{n}$ is the ideal sample size obtained by fitting value points into the unit circle's probability space under equation (29).

Table 3. Power calculation for sample size determined by CDF of scale components

Scale	n_ϕ	n^*	$n_\phi - n^*$	Π	Π%
(1,0)	33.61	30.07*	3.54	0.8823	88.23%
(0,1,2,3)	30.58	30.07	0.51	0.9830	98.30%
(1,2,3,4,5)	30.20	30.07	0.13	0.9957	99.57%
(1,2,3,4,5,6,7)	29.79	30.07	0.28	0.9907	99.07%
(1,2,3,4,5,6,7,8,9,10)	29.51	30.07	0.56	0.9814	98.14%

*Using E = 0.05 and $\sigma = 6$.

The power we proposed differs from the tradition power calculation for sample because we do not depend on the value of β , but based power on the ratio between the data points that can fit into the probability space of the unit circle. A theoretical or expected sample size is defined as the saturation of data points that would fit into a unit circle obtained under Monte Carlo simulation. This approach is more practical because we based our sample calculation on the CDF of the response scale used in the survey, not on parameter estimate in the population. We assert that in social science research where survey is used and quantitative response is employed, the expected value for the entire survey should lie within the range of the max and min values of the scale used in the survey. Thus, the basis for calculating sample size should be the survey scale, not some population parameter estimate. The observed value for the sample and the expected value in the population will fall within the max and min values of the scale used.

4.0 FINDINGS AND ANALYSIS

4.1 Standard sample size for quantitative survey using probability function

Using the Monte Carlo simulation to fit data points into the probability space of a unit circle, we found that for 6-sigma with error level of 0.05, the ideal sample size is 30.07. This fitted value is

used as a threshold value against which sample size obtained through survey response scales are compared. Table 3 tabulates various threshold sample size of –sigma with various levels of error.

Table 4. Threshold sample size under 6-sigma under various error level

σ	E	$\hat{N}$	$\ln(N)$	$n^* = \ln(N)\pi$
6.00	0.01	360,000	12.79	40.17
6.00	0.02	90,000	11.41	35.82
6.00	0.03	40,000	10.60	33.27
6.00	0.04	22,500	10.02	31.47
6.00	0.05	14,400	9.57	30.07
6.00	0.06	10,000	9.21	28.92
6.00	0.07	7,346.94	8.90	27.95
6.00	0.08	5,625	8.63	27.11
6.00	0.09	4,444.44	8.40	26.37
6.00	0.10	3,600	8.19	25.71

By using the cumulative probability of each element of the scale as the basis to calculate the sample size, we are able to determine the sample size for the various scales commonly used in quantitative research that employ written survey. Note that in this new approach, we also include discrete or binary data. In all cases, regardless of discrete or continuous and regardless of whether Likert or non-Likert scales used in the survey, we found that the minimum sample size is approximately 30. Table 4 shows the estimated sample size based on probability function for each survey response space.

Table 5. Using cumulative function of response scales to obtain sample size

Scales	$\bar{X}$	S	$\bar{Z}$	E	N	$n_\phi = \ln(n)\pi$
(1,0)	0.50	0.71	0.50	0.01	16,970	33.61
(0,1,2,3)	1.50	1.29	0.50	0.01	15,045	30.58
(1,2,3,4,5)	3.00	1.58	0.50	0.01	13,172	30.20
(1,2,3,4,5,6,7)	4.00	2.16	0.50	0.01	12,067	29.79
(1,2,3,4,5,6,7,8,9,10)	5.50	3.03	0.50	0.01	44,456	29.51
					Mean ± SD	30.74 ± 1.65

The use of the CDF as the basis for sample size calculation had been done in the past. However, the approach taken in the past was different than what we proposed in this paper. In the past, sample size calculation under CDF approach is obtained through:

$$n_{old} \geq \left(\frac{Z_\alpha + \Phi^{-1}(1-\beta)}{\mu^*/\sigma} \right)^2 \tag{31}$$

Assume that for 95% confidence interval, $Z_\alpha = 1.65$ and $\beta = 0.05$, and μ and σ are inferred from an observation set. In this study, we test the power of this equation by using the response scale as the observation set. We find this approach inefficient because the use of depends on a test sample to obtain the inferential statistics of μ and σ. The values of these two components are not stable as the test sample size changes.

The comparative findings of sample size under these two methods using various response scale types are reported in table 5. Note that when use the response scale as the observation set to

determine sample size, the old sample size calculation method failed to produce adequate sample size and also failed in the power test under equation.

Table 6. Comparison of two types of CDF-based sample size calculation

Scale	n_{old}	n_{new}	Π_{old}	Π_{new}
(1,0)	196.20	33.61	-4.52	0.8823
(0,1,2,3)	59.43	30.58	0.02	0.9830
(1,2,3,4,5)	5.11	30.20	0.17	0.9957
(1,2,3,4,5,6,7)	4.59	29.79	0.15	0.9907
(1,2,3,4,5,6,7,8,9,10)	4.12	29.51	0.14	0.9814

Note: Π_{old} is equation (31) and Π_{new} is equation (30). The n_{new} is n_{ϕ} that we proposed in this paper.

5.0 CONLCUSION

There are many sample size methods in the literature. These methods may be categorized into two types: (i) population-based, or (ii) data-based whether the data is discrete or continuous. Under the population-dependent approach to sample size calculation, there are at least two types of sample size calculation method depending on whether the population is known or unknown. For the data-based approach to sample size calculation, there are also many formulas used to calculate sample size depending on whether the data is discrete or continuous. These two lines of literature with their varied formulation caused uncertainty and confusion in sample size calculation. In this paper, we provide a general case of sample size calculation based on the CDF of the scale of the survey used in the research. By employing the scale as the data for Monte Carlo simulation, we are able to obtain the expected sample level at about 30 counts for both discrete and continuous data. In addition to new sample size calculation method, we also propose a new tool for power calculation. The new power calculation uses the actual sample size obtained from the survey scale and the expected sample size obtained from Monte Carlo simulation of 6-sigma case. This power calculation method is more efficient and practical.

REFERENCES

Cochran, W. G. (1963). *Sampling Techniques*, 2nd Ed., New York: John Wiley and Sons, Inc.; p. 75.

Devane D, Begley CM, Clarke M. (2004). "How many do I need? Basic principles of sample size estimation." *J. Adv. Nursing*. **47**: 297–302. https://www.ncbi.nlm.nih.gov/pubmed/15238124

Francis, J. J., Johnston, M., Robertson, C., Glidewell, L., Entwistle, V., Eccles, M. P., & Grimshaw, J. M. (2010). "What is an adequate sample size? Operationalising data saturation for theory-based interview studies." *Psychology and Health*, **25**, 1229–1245. doi:10.1080/08870440903194015

Fugard A.J.B.; Potts H.W.W. (10 February 2015). "Supporting thinking on sample sizes for thematic analyses: A quantitative tool." *International Journal of Social Research Methodology*. 18 (6): 669–684. doi:10.1080/13645579.2015.1005453.

Galvin R (2015). "How many interviews are enough? Do qualitative interviews in building energy consumption research produce reliable knowledge?" *Journal of Building Engineering*, **1**: 2–12.

Glaser, B. (1965). "The constant comparative method of qualitative analysis." *Social Problems*. **12**, 436–445.

Gogtay, Nithya J. (2010). "Principles of sample size calculation." *Indian J. Ophthalmol*. 2010 Nov-Dec; **58**(6): 517–518. doi: 10.4103/0301-4738.71692 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2993982/

Guest, G., Bunce, A., & Johnson, L. (2006). "How many interviews are enough?: An experiment with data saturation and variability." *Field Methods*, **18**, 59–82. doi:10.1177/1525822X05279903

Israel, Glen D. (1992). "Determining Sample Size." Fact Sheet PEOD-6; November 1992 http://sociology.soc.uoc.gr/socmedia/papageo/metaptyxiakoi/sample_size/samplesize1.pdf

Julios S.A. (2004). "Sample sizes for clinical trials with normal data." *Stats Med.* **23**: 1921–86. https://www.ncbi.nlm.nih.gov/pubmed/15195324

Karlsson J, Engebretsen L, Dainty K. (2003). *ISAKOS scientific committee Considerations on sample size and power calculations in randomized clinical trials. Arthroscopy*; **19**: 997–9. https://www.ncbi.nlm.nih.gov/pubmed/14608320

Noordzij, M. , Tripepi, G., Friedo W., Zoccali, D.C., Tanck, M.W. and Jager, K.J. (2010). "Sample size calculations: basic principles and common pitfalls." *Nephrol Dial Transplant*, **25**: 1388–1393. CME Series. doi: 10.1093/ndt/gfp732 https://academic.oup.com/ndt/article-pdf/25/5/1388/5213790/gfp732.pdf

Onwuegbuzie, A. J., & Leech, N. L. (2007). "A call for qualitative power analyses." *Quality & Quantity*. **41**, 105–121. doi:10.1007/s11135-005-1098-1

Sandelowski, M. (1995). "Sample size in qualitative research." *Research in Nursing & Health*, **18**, 179–183.

Smith, M. F. (1983). "Sampling Considerations," *In* Evaluating Cooperative Extension Programs. *Florida Cooperative Extension Service Bulletin PE-1*. Institute of Food and Agricultural Sciences. University of Florida.

Wright, A., Maloney, F. L., & Feblowitz, J. C. (2011). "Clinician attitudes toward and use of electronic problem lists: a thematic analysis." *BMC Medical Informatics and Decision Making*, **11**, 36. doi:10.1186/1472-6947-11-36

Yamane, Taro (1967). *Statistics, An Introductory Analysis*, 2nd Ed., New York: Harper and Row; p. 886.

Cohen, Jacob (1988). *Statistical Power Analysis for the Behavioral Sciences*; P. 67. Routledge. ISBN 978-1-134-74270-7.

OFFICE OF THE EDITOR-IN-CHIEF
International Journal of Research & Methodology in Social Science (IJRMSS)
55 / 123 Rangsit-Nakhon Nayok Rd.
T. Lampakkood, A. Thanyaburi
Pathumtanee, THAILAND 12110
Email1: Editor@socialsciencepublication.com
Email2: EditorIJRMSS@gmail.com
Website: www.socialsciencepublication.com

JOURNAL

The International Journal of Research and Methodology in Social Science (IJRMSS) is a double blind peer-review, open access, academic research, published quarterly. The journal publishes research articles, literature review articles, technical commentaries, and case studies.

MISSION

The mission of the journal is to provide publication service to the academic and research community in social science that is: (i) peer reviewed, (ii) high exposure, (iii) true open-access, (iv) fully achieved and retrievable online, and (v) leads to impact factor score.

OBJECTIVE

The objective of the journal is to provide an open access online forum and resource for researchers to share, disseminate, and exchange ideas and research outcome through peer reviewed publication.

POLICY

It is the policy of the journal to provide high quality research publication that is a true open access journal. The journal is committed to "no fees – no charge" to authors. All articles will be subjected to blind peer review process. We are committed to high quality research publication with free online access and strictly observe non-predatory publication policy.

PRINCIPLES OF TRANSPARENCY AND BEST PRACTICE IN SCHOLARLY PUBLISHING

IJRMSS subscribes to the Principles of Transparency and Best Practice in Scholarly Publishing as recommended by Committee on Publication Ethics (COPE), the Directory of Open Access Journals (DOAJ), the Open Access Scholarly Publishers Association (OASPA), and the World Association of Medical Editors (WAME). A copy of the Principles of Transparency and Best Practice in Scholarly Publishing may be downloaded here: CLICK.

CALL FOR PAPERS

IJRMSS is published quarterly. Our call for papers is on-going. Authors may submit the research article(s) by email to: Editor@socialsciencepublication.com or EditorIJRMSS@gmail.com. We welcome articles in the following fields and their interdisciplinary

SOCIAL SCIENCE	**INTERDISCIPLINARY**	*Forestry*
Anthropology	*Applied physics*	*Library science*
Archaeology	*Artificial intelligence*	*Mathematical & Theoretical biology*
Criminology	*Bioethics*	*Mathematical physics*
Demography	*Bioinformatics*	*Medicine*
Economics	*Biomedical engineering*	*Military science*
Geography (human)	*Biostatistics*	*Network science*
History	*Cognitive science*	*Neural engineering*
International relations	*Complex systems*	*Neuroscience*
Law	*Computational linguistics*	*Science studies*
Linguistics	*Cultural studies*	*Scientific modeling*
Pedagogy	*Cybernetics*	*Semiotics*
Political science	*Environmental science*	*Sociobiology*
Psychology	*Environmental social science*	*Statistics*
Science education	*Environmental studies*	*Systems science*
Sociology	Ethnic studies	*Urban planning*
	Evolutionary psychology	*Web science*

All papers submitted must conform to the following format:

Font:	Times New Roman 12 points
Margin:	Single line spacing; 1 inch top, bottom, right & left.
Reference:	APA style. For example Click.
File:	MS Words. Originality will be checked by TURNITIN.
Template:	DOWNLOAD

COPYRIGHT

The fact that a work is unpublished shall not itself bar a finding of fair use if such finding is made upon consideration of all the above factors. *See* Pub. L. 94–553, title I, § 101, Oct. 19, 1976, 90 Stat. 2546; Pub. L. 101–650, title VI, § 607, Dec. 1, 1990, 104 Stat. 5132; Pub. L. 102–492, Oct. 24, 1992, 106 Stat. 3145."

ERRATA

In case where an error escapes the review process or is discovered after the publication has already been released, IJRMSS will contact the author for written comments and/or correction, and the journal will publish the correction in the *errata* section in the subsequent issue no later than 2 publication cycles after the error has been discover. Errata will be published when the error is material and may mislead or misrepresent facts. Minor error, such as typographical error or unless it involves mathematical formula, does not compel errata publication.

PLAGIARISM

IJRMSS maintains strict policy on originality of works and proper credit given to prior sources. We employ computer software to check for work originality. The article found more than 10% similarity with prior works will be automatically rejected for cause and no invitation for resubmission would be issued. Originality check does not count instances of citation and repeated citation of names, titles, and/or sentences and paragraphs in quotation or in-text quotation when proper quotation marks are used.

DISCLAIMER

The opinions expressed in each article are those of the individual author(s). Specific questions about the article should be directed to the corresponding author(s). The contact information of the corresponding author is listed in the footnote on the first page of the article marked with a star: ★. IJRMSS has editorial discretion to decline articles that are demeaning or disrespectful or otherwise intended to cause public outcry in matters of race, national origin, religion, ethnicity, and/or sexual orientation where public sensitivity outweighs the academic value of the proposed article(s).

INTERNATIONAL JOURNAL OF RESEARCH & METHODOLOGY IN SOCIAL SCIENCE
VOL. 5, NO. 1 | JAN. – MAR., 2019 | QUARTERLY JOURNAL | ISSN 2415-0371

Scientia, Fortitudo & Victoria

OPEN ACCESS

Berlin Declaration of Open Access to Knowledge in the Science and Humanities
Budapest Open Access Initiatives
The Cape Town Open Education Declaration

INTERNATIONAL JOURNAL OF RESEARCH & METHODOLOGY IN SOCIAL SCIENCE
ISSN 2415 – 0371

OFFICE OF THE EDITOR-IN-CHIEF
Email: Editor@socialsciencepublication.com

Correspondence
55 / 123 Rangsit-Nakhon Nayok Rd.
T. Lampakkood, A. Thanyaburi
Pathumtanee, THAILAND
Email: EditorIJRMSS@gmail.com

www.socialsciencepublication.com

ISSN 2415-0371

Find us on: facebook | LinkedIn | follow us on twitter | Google Scholar