Abstract

Making psychology laboratory science in Nigeria - the Africa's more populous and economically buoyant nation - as competitive as possible is like a bridge too-far-to-cross. Every year, there is a feeling that in a near future the state of psychology in Nigeria will blossom, and therefore formidable psychology laboratory experimental studies will abide. But as years roll on, such prospect is increasingly becoming an illusion, if not a deceptive trend. Commonsense and anecdotal evidences point to the fact that Nigeria is yet to have the fundamental structures, cultural environment and thought processes commensurate with initiating and sustaining a scientist-practitioner model presently fashioned in modern psychology. Although commanding the greatest number of universities in Africa, largest shear of educated population, and endowed with abundant natural and human recourses, psychology laboratory studies in Nigeria is impoverished at best and inexistent at worst. If anyone claims the opposite of this observation, such optimism can only be described as a phantom of reality driven out of self-serving bias. Although written from psychology's perspective, this article acts as a wakeup call, not only to psychology, but also to all other laboratory-based field of studies in Nigeria. The article is aimed at calling attention to some of the militating factors that weigh against Nigeria's ability to achieve a formidable scientific breakthrough of their own. This attempt, we believe, will help to dispel some misleading thoughts about psychology as a science, which we thought grew from ignorance and poor structured psychology programmes adopted in many Nigerian Universities.

Key Words: Psychology laboratory research, experimental research, science, experimenter effects, experimental design, ecological validity, psychology lab equipment, experimental psychology.

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Introduction

To say the least, modern psychology is not African, and its structural framework, is definitely alien to African conceptual framework and culture. Like every fields of professional studies, psychology was introduced in Africa during the colonial era (Ajelu, 2016). However, unlike other fields of studies, psychology and psychological services still remain unpopular in Nigeria Universities and with the general public (Zamani, 2015). In its initial efforts to "indigenize" or "Africanize" modern psychology, it is obvious that the paradigm shift from folk psychology (which is native to Africa) to empirical and analytical psychology (which is native to the West) was mishandled or in some manner, misconceptualized. It is the beliefs of experts that due to wrong approach, lack of appropriate tools, inadequate concepts and the use of outdated training models modern psychology in Nigeria is still suffering from major set-backs (Zamani, 2015). For this perspective, the onset of modern psychology was founded and structure baseless paradigm shift, resulting in ill-conceived knowledge-base and competency needed to understand the practical and intellectual sophistication of modern applied psychology. Such poor foundation might have contributed poor transition from folk to modern psychology.

Nigeria has the oldest University in Africa, and certainly the first to start offering courses in psychology, as well as the first to establish independent psychology departments. However, for more than 50 years after Nigeria's Independence, modern psychology, as an independent discipline, is only taught in 28 of 148 universities in Nigeria (Ezeokana, 2015). Invariably, when one weighs the quality of psychology training and programme in these Nigeria Universities against those of the developed world, one certainly agrees that Nigeria indeed has a very long bridge to cross. The onus is even greater when laboratory experimental psychology is factored in. While maintaining that the sophisticated nature of modern psychology laboratory and programmes, which is difficult to achieve by Nigerian standard of leadership and administration in educational systems, one also acknowledges the harm caused by infiltration of incompetent and ill-trained lecturers employed to teach psychology in newly established psychology departments. According to Zamani (2015), these people whose major degrees were in education, theology, philosophy or medicine, claimed to be "psychologists based on previous [elementary]exposures to psychology (Zamani, 2015, p.94),"and produced graduates with substandard background and skill in modern empirical and analytical psychology. Without further exposure and experience, these graduates were employed to teach in the same university. Hence recycling mediocrity!

For psychology laboratory science in Nigeria to meet the taste of time, it must redress the fundamental problems facing psychology departments especially in making sure that high-profile (core) courses are allocated only to competently trained lecturers, based on their pre- and post-doctoral education, specialization, consultation, and professional experience (APA, 2002/1987). Courses in experimental psychology should be included for all post-graduate students, and these students should be persuaded and encouraged to conduct experimental research for their thesis.
and dissertation, and also provide them with adequate environment and instruments for psychology laboratory studies.

In America, for example, programme in psychology starts after a College (Bachelor's) degree, and one must take a Graduate Record Examination (GRE) to ascertain individual's mental ability and emotional stability to handle the stress-packed programmes offered in psychology (Johnson-Laird, 2002). The requirement for becoming a (clinical) psychologist is a PhD, which carries about 160 credit hours and may last up to 5 to 6 years. Yet one is not regarded as a psychologist until he or she is licensed, which takes another one or years of clinical experience under a licensed and experienced psychologist. One is not even allowed to teach or supervise graduates of psychology students without being licensed, and a proof of post-doctoral specializations.

In Nigeria, on the other hand, the National University Commission (NUC) upholds a Master of Science degree as a qualification for the title of psychologist (Zamani, 2015), which takes only 22 credit hours to complete. A doctorate degree (PhD) carries little or no serious course works, but culminates only around seminars and dissertation. Following the modern trend in modern psychology however, the knowledge-base required in America to earn a doctorate degree in (clinical) psychology overwhelmingly outweigh what the NUC (in corroboration with the Nigerian Psychological Association) upholds as requirements for Nigeria. The point is that there is no way students trained under this limited knowledge-base will be well equipped to advance the science of psychology, popularize psychology in Nigerian and compete favourably with their counterparts overseas.

Is Psychology as Science?
I was surprised when a lecturer in a psychology department questioned whether psychology is "really" a science, and believed that psychology laboratory students ought not to wear lab coat because "they are not real scientists." I understood the problem immediately. As the lecturer was educated in Nigeria, with poor track-record in psychology laboratory science, he was short-charged in the science of psychology. For this reason, my surprise changed to sympathy, and a resolve to paint a real picture of modern psychology. Science deals with interconnected series of concepts and conceptual framework, which emerge through experimentation and observation (Solso & Johnson). Its approach is based on the basic assumption that the structure of the universe is governed by the law of order, empiricism, determinism, parsimony (precision), testability (reliability and validity), and replicability. Science tries to understand the world through prediction and experimentation. Invariably, psychology's scientist-practitioner model holds the same claim as other science-based fields like, chemistry, biology, and physics. That is, science is essentially an attempt to understand human nature and the physical world through experimentation and observation, guarded by basic laws and principles of nature (Dehue, 1997; McGuigan, 1997). These laws and principles require that scientists have certain level of decorum, intellectual ability and personal comportment. From the time psychology became an independent field that studies behaviour it has pursued the course of scientific investigations through
experimentation and observation, and has an impeccable track-record in studying behaviour and cognition from empirical and laboratory studies. This is buttressed by the vigour with which the first generation psychologists, who were eminent physicists, doctors, chemists and scientists, pursued the course of experimental science and thus established formidable laboratories with sophisticated laboratory equipment and amiable scientific breakthroughs.

The establishment of psychology laboratory was one of there markable legacy left by early pioneers, especially Whelm Wundt of Germany, James Cattell of America, and host of others. Since then, psychology laboratories, especially in developed nations, have continued to grow in sophistication and seriousness (Dehue, 1997). This endeavour has enabled researchers and scientists make remarkable contributions to the development knowledge and in our understanding of the world around us (King & King, 1990). The methods of research employed in psychology follow the canons of science and apply rigorous statistical techniques used in other natural sciences. Using humans and animals in psychology lab as subjects, psychologists enliven the same direct observation, manipulations of variables and hypothesis testing applied by all biologists, bioscientists, neurologists, pharmacists and others fields that link their ancestry to natural sciences. It is on this that psychology, as a behavioural science, is recognized as a natural science, and psychologists who are specially trained under the scientist-practitioner model or other models are truly scientists in all ramifications (King & King, 1990). Psychology students who are trained to become future researchers are scientist-in-making and should be proud of the wonderful contributions of psychology has made to the development of health care, career, and social well-being.

**White coat for Scientists: Are Psychologists included?**

I had already narrated my experience with a psychology lecturer, who believed that psychology is not a "real" science, and therefore students in experimental lab should not wear white coat meant for scientists. Even though this lecturer has a PhD degree in psychology, he was still not of the understanding that the course in experimental psychology, if well taught and furthered through personal commitment, would have qualifies him as a scientist. In my overseas training, precisely in the United States, the sophistication of psychology laboratory training sends a strong

![Figure 1: traditionally required Protective gears for Lab Scientists](image)
message to even a doubting-Thomas that psychology is indeed the home of science. Since clinical psychology is often housed the faculty of health sciences or department of psychiatry, collaboration with medical, bioscience and physics students, are very common, and therefore dispelling the question as to whether a psychologists is a scientist. Beyond this, however, the seriousness given to experimental psychology is second to none. Entering an average sized psychology lab in the United States, one sees sophisticated and sometimes scary equipment comparable to those seen in other natural science laboratories (Soloso, Johnson & Beal, 1998). Like every other laboratories, wearing lab coat, gloves and mask is a matter is protection rather than an insignia (symbol or token of personal power, status or office).

In other word, its original purpose was mainly to protect scientists from fire, contaminants, microbial, and to preserve their street attire from stains. In our society today, the lab white colour coat has three purposes, a) to protect your main clothes from stains, b) for easier dictation of filths, and c) as a sign of honesty and purity for which scientists are obliged to uphold while in closed doors (laboratory).

The introduction of animals as laboratory research subject made personal protection of scientists more crucial. The psychology lab, which is one of the original science laboratories that uses animals as subjects, and for this reason, required lab coat, gloves, face mask and even eye glasses (see Figure 1), for safety and insignia. Ethical rules were put in place to protect both scientists and lab animal (APA, 2002). In Nigeria were such rules are not in place or enforceable, the safety of individual students and professional scientists who manipulate animal as part of their training or contribution to knowledge must be held in utmost consideration. As animal-to-human borne diseases loom, especially in Africa, protection of student-researchers and university lecturer-scientists much not be compromised. As you can see, lab coat is not merely an insignia for bioscientists or pharmacists or doctors, but for all fields of science that: a) conduct scientific research in laboratory, b) use instruments or employs subjects that may present a health risk or physical hazard to researchers, and c) the field that qualifies for science-insignia. The science of psychology ultimately qualifies for all these conditions.

**The Identity of a Scientist**
There has been an argument as to whether a scientist is born to beor a derivation of the environment. The questions, who is a scientist? What are the qualities of a scientist? Or is the mind of a scientist naturally constituted or just driven by environmental experiences, are pertinent questions that drives scientific investigations. However, answering these questions
broadly leads us to the nature-nurture debate, which is outside the scope of this work. We would categorically state that primarily a scientist is a human endowed with natural dispositions and adaptive potentiating quantities. Simply stated, a scientist is one who uses natural traits and environmental clues to rigorously pursue knowledge through scientific processes. Experts believe that nature and nurture endowments are very important in the making of a scientist because the two compliment and in some way, counteract each other. For example, good nature (gene) interacting with good nurture (environment) leads to excellent mental and behavioural equilibrium. Invariably, bad nature counteracts good nurture is a problem, while bad nurture renders desolate a good nature. It can be said, therefore, that since some characteristics are especially important in becoming a scientist, a scientist's identity is learned and acquired.

Modern science and scientific thinking are Western in origin, and therefore have the Western frame-of-reference (a set of ideas, conditions, or assumptions that determine how something will be approached, perceived, or understood through which people think and conceptualize realities). Even though Africans were colonized by the West, it is certain that the axes of science and scientific thought processes as frame-of-reference were not transferred to Nigerians. This is because science and its processes are acquired through the interaction of nature (acquired knowledge) and nurture (learned knowledge), which help an individual cultivate the appropriate mind and attitude. Any attempt to separate the Western frame-of-reference from science renders the idea of science insolvent (Levitt, 2013). Since nature’s secrets are revealed reluctantly, scientists must have not only the natural disposition, but also the conducive environment to uncover nature's realities. This means that scientists must have both intellectual and personal characteristics like confident, courage, patient, tolerant of change and open-minded.

There is no doubt that Nigerians have natural disposition (gene pool) to science, and there is also no doubt that the cultural environment in which an average Nigerian grew up from is deficient of necessary characteristics that constitute the identity of a scientist. The science-identity to an individual is infuses by the gene-environment interaction (Craddock, 2011; Traynor, 2010). While the Nigeria child could be endowed with the natural disposition to science, it is not without saying that a typical Nigeria child is by default deprived of the environmental component that compliments or mediates nature. For example, the development of relevant characteristics concerning one's environmental elements is essential in adaptive qualities like curiosity, confidence, courage, patient, objective, tolerant of change and open-minded (Brescianini, Volzone, Fagnani, Patriarca, Grimaldi... Stazi, 2011), which are vital to becoming a
scientist. These are psychological and mental traits that can be advanced or destroyed by the type of environment a child is exposed in.

On the other hand, a benefiting environment is one where the developing child feels empowered and protected against undue intimidation, timidity and physical and mental abuses that may destroy his or her natural disposition (Craddock, 2011). Hence, an environmental structure that expedites scientific culture in a child should be one that readily answers a child's questions appropriately, safeguards the child's mental and emotional well-being against undue abuses by patients or others, exults child's right to personal options and identity, and makes his or her surroundings reinforcing and assuring. These lead to trust, confidence, self-comportment and regulation, self-efficacy (an inner feeling of strength and an ability to evaluate oneself accurately), and balanced self-esteem. Additionally, distrust of the world, timidity, lack of confidence, low self-esteem, selfishness, and irrational thinking may arise when a child is raised up in a threatening, hostile, intimidating, hash, brutal and dysfunctional environment.

**Trends in Nigerian Society that Impede Scientific Growth**

1. **Child-unfriendly environment**: The Nigerian child grows up in a child-unfriendly environment, loaded with chaotic, dysfunctional, and intimidating relationship between children and adults, where physical abuse like, beating, spanking, food deprivation, tortures and other brutal and harsh methods of corporal punishments are culturally accepted and dangerously enforced. Such environment, as predicted by experts leads to mental and emotional trauma and deprive the child self-confidence, self-efficacy, trust, and empathy and assertiveness. As early as age 4, most, if not all children in Nigeria, are exposed to neglect, merciless physical and sexual abuses, and mental deprivations. Beating, flogging, spanking and public humiliations are frequently used in nursery, primary and secondary schools as means of training and correction. At home, the child is not spared from brutal punishment from angry and abusive parents or caregivers. Even in Universities, aggressive beating of students by angry and abusive lecturers is treated with carefree attitude. Thousands of theoretical and empirical research findings since the 18th century have demonstrated that there is no positive benefit in raising children in violent, brutal, dysfunctional and chaotic environment. Such children are mental and psychologically messed up and socially maligned. Yet everybody, including the government and the academic community, ignores the danger of corporal punishment on children's mental alertness and creative thinking. Apart from the mental torture, children are exposed to horribly disorganized family, community, and school environment. From nursery to university, the child sees his or her
environment as disorganized, filth, and in a malign neglect of decency, safety, beauty and general hygiene. Environmental conditions, such as these, produce careless, mistrusting, irritable, explosive, disorganized and irresponsible adults, which are antithesis to a scientist's identity.

2. Belief System: Nigerian belief system and emotionality are other environmental hazards that seem to impede or demoralize the development of science and scientific mind-set. Superstition, a belief in supernatural causality, is inimical to science and scientific thinking, but this belief system is highly regarded as a life-wire of an average Nigerian. Regardless of education and economic status, there is an inherently superstitious belief pattern in many Nigerians (Ajaelu, 2004). Interpretation of natural phenomenon is anchored in supernatural beliefs and things in themselves are believed to have meaning only through spiritual connections. In a research conducted by Ajaelu (2004), it was shown that about 85% of medical (psychiatric) doctors, clinical psychologists and 95% of (psychiatric) nurses in Nigeria believed that most illnesses can be linked to "evil forces." However, the same type of research conducted in Americans showed 2% and 5% respectively approved supernatural forces as illness causation. This is a great problem to the growth of science in Nigeria, because such beliefs exert negative influence on parent and society who inevitably transfer them to children and even teachers, which impedes individual's conceptualization of basic scientific knowledge.

The empty barrels makes the most noise Syndrome: The truth of this old saying has been subjected to many types of experimental investigations and the findings were that poorly developed cortical connection (executive functions) creates "hallow" in reasoning which is compensated by the primitive brain (raw emotion, unmediated by reasoning) (Harris & Mrsic-Flogel, 2013). For reason beyond this article, Nigeria is emotionally charged, with tendency to explosiveness and yelling, often seen as part of self-expression, respect and power command. It is indeed believed that the loudest one's voice is, the more believable, the more acceptable, and the more rational he or she appears. For this reason, loud vocal expression of feelings (raw emotion) and explosive behavioural outburst are major modes of inserting one's superiority, authority and power (Bouchard, 2009). This culturally accepted pattern of behaviour is readily seen among people of all ages, educational and political backgrounds. It is mostly observed in body language or group conversation, greetings, use of artificial sound systems, structural patterns, religious worship, and even fashions. But experts believe that such behavioural components are external signs of mental and personality misbalances orchestrated by subconsciously harboured inadequacies (Ask MetaFilter, 2014). Although, emotion enhances human expression of selfhood and interpersonal relationship, but when imbalanced, it becomes counterintuitive to scientist's identity. Mental intelligence is mostly valued in a person because it is the faculty that balances the activities of the primitive brain (van der Maas, Dolan, Grasman,Wicherts, Huizenga, Raijmakers, 2006). When adequately developed, cortical connections highlight ability to understand complex ideas (Scholl&Priebe, 2015), adapt
effectively to the environment, learn from experience, engage in various forms of complex reasoning (Price, Dehay, Zhou, Mercier... Molnár, 2006), overcome obstacles through critical and analytic reasoning and creative thought processes (Colom, Karama, Jung, Haier, 2010).

Lower animals, like the primates, do not have mental intelligence (executive function), but have a well developed primitive brain that helps them insert their power and superiority in order to assure their survival. They use vocal intimidation, aggression and loud noise to assert their supremacy. Primitive brain, also shared with humans, is the site for emotions, aggression, and violence, and can be ruthless and deadly if not mediated by mental intelligence (Schmidt & Hunter, 2004). So, humans, endowed with mental intelligences, insert their survival, power, and superiority through mental processes mediated by critical reasoning, thinking, discipline and principle of law and order (Gottfredson, 2004). Science cannot grow and strive in an emotionally charged environment. Growing up in an environment saturated with explosive emotions does great harm to a child's mental and rational developments, most needed for scientific thinking and reasoning. Loud and hysteric yelling and shouting, even while engaged in a friendly conversation are emotional characteristics common in Nigeria. In airports, streets, schools and universities, offices and restaurants, and even in churches, one is confronted with atmosphere saturated with noise and explosive behavioural outburst. Even though some believe that such raw emotional outburst is cultural, but it is a culture that robs the Nigerian child the abilities to critical thinking and analytic ally, needed in science and scientific investigations.

**Time and measurement**: Time and measurement are inevitable to science and central to developing scientific mind. If this is the case, then count a typical Nigerian out of science because Nigerians are chronically and inherently no respecter of time and measurement processes are rarely part of their lifestyles. The human brain circadian (biological clock) has been linked to chemical kinetic, which helps humans prepare and anticipate precise and regular environmental changes. As disruption in circadian rhythm also affects the *internal* metabolic processes, coordinating with the environment (Sharma, 2003), it means that lack of time consciousness is a mental distortion of kinetic processes and synchronization of body changes with environmental changes. Hence, lack of time-consciousness derails curiosity, analytic mind and planned action which are central to scientific investigations.

**Experimental Psychology from Purely Scientific Orientation**

Becoming a scientist or an experimenter is a passion. It is a calling or a vocation. It is a calling that requires ultimate discipline, tranquil and impetus character, as well as mental and intellectual abilities to embrace the sophisticated and methodological processes of scientific investigation (Levine & Parkinson, 1994). The science of psychology relies heavily on *experimentation*, manipulating variables, navigating between reliability and validity of research in order to arrive at a true knowledge. The terms reliability (consistency, capacity of a research to be replicated by other scientists) and validity (factual accuracy of observations) are
very essential tools in psychological science. This is because they make sure that experimentation, instrumentation, and rational analysis are less susceptible to subjective interpretation or idiosyncratic bias. Experimentation hinges on the understanding of **experimental designs techniques**, which entails skills and knowledge on how to handle laboratory or naturalistic observations, understand the dynamics of laboratory instruments, how to manipulate and control variables, as well as how to analyze and interpret findings with different statistical instruments.

The science of psychology distinguishes two major categories of scientific research methods, namely **experimental** and **non-experimental** methods. Experimental method is conducted to test hypotheses in order to discover a **cause and effect relationship** between two or more variables. It is quantitative (numerical) in nature and uses interval and ratio scale as its major measurement protocol. Comparatively, non-experimental method is conducted to collect data on variables, but principally conducted to collect data on variables, not to test hypotheses about the relationships between them. In other words, it is a research that lacks the manipulation of an independent variable, control of extraneous variables through random assignment, or both. There are three broad types of non-experimental research, namely: Single-variable research that focuses on a single variable rather than a relationship between variables, correlational and quasi-experimental research that focus on a statistical relationship.

Experimental research is high in **internal validity** (the capacity of an experiment to avoid confounding). In many departments or schools of psychology all over the world experimental research is emphasized more than non-experimental research. In Nigeria, however, many universities heavily emphasize non-experimental research, survey studies and correlational research.

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**Tip 1: Rules & Processes in Experimental Psychology**

1. Look for the “**pop-out effects**,” and follow your **Instinct and curiosity**.
2. **Observe** and **ask questions** to identify the problem.
3. Develop a **study topic**, and seek to **investigate your observation**.
4. **Raise research questions**, and formulate **hypothesis**
5. Identify research **variables**, locate the **independent and dependent variables**, and distinguish relevant from irrelevant variables and **conceptually and operationally define your variables**.
6. **Locate from Population**, and draw your research sample.
7. **Formulate an experimental design** to minimize threats posed by confound variables.
8. **Establish your treatment group by randomly assigning groups to subjects**.
9. **Conduct the study**, collect data, and statistically **test your hypothesis**.
Experimental Paradigm
The tendency for an experiment to remain originally scientific lies in adherence to a ten-stage procedural rule (see Tip 1). Understanding and internalizing these rules help a beginner in experimental psychology to easier head-start in knowledge of experimental psychology. In the first rule (see Tip 1), the ability to critically analyze situations and creatively isolate sense (reason) from nonsense (irrational) are essential to science. The "pop-out effect" (a light in the brain or a "revelation" or "inspiration") unlocks our consciousness about things around us. Sound mind, intelligence, strength of character, and personality help a scientist to distinguish illusion and sound reasoning. Traumatized and socially dissolute children, however, cannot have analytic and creative minds. If they did have them at birth, depraved environment and wicked cultures will inhibit them.

A scientist's curiosity and natural or innate inclination (instinct) lead to pungent observations and questions about life and environment. It is through observations and questions that the scientists formulate a theory (a set of coherent and explanatory proposition, used to make empirical prediction) about events, and theory, in turn, leads to hypothesis (generalization derived or deduct from theory). Hypothesis, in its own right, is formulated to test occurrence or changes (variability) in phenomena (variables). Testing a hypothesis is carried out to accept or reject changes observed events (variables), and it is based on the fact that the first event (called cause) is responsible for the charges observed in the second event (called effect). This is why experimental psychology primarily deals with cause-and-effect relationship. However, a correlation between two variables does not imply causation. On the other hand, if there is a causal relationship between two variables, they must be correlated. For example, we may ascertain a correlation between watching violent movies and aggressive behaviour, but we cannot not at the same time conclude that watching violent movies causes aggression. From this view, the idea that a hypothesis is an "educated guess" makes no meaning to the standard premise to which hypothesis is based. Experimenters deal with educated propositions or predictions, not necessarily guesses. Since a guess, in its right, is divulged of sufficient information to be sure of being correct, and therefore thrives in speculation, it is counterintuitive to scientific principles (Ghose, 2013). Such a term should not be used to define hypothesis, rather it should be developed from in-depth observation and analysis of events (Charness, Gneezy, & Kuhn, 2012).

In laboratory experiment, research is conducted under highly controlled conditions, and emphasizes manipulating variables and testing hypotheses. Understanding the characteristics and dynamics of research variables, namely, the independent variable (IV), the dependent variable (DV) and extraneous variables (EV), is necessary in arriving at an appropriate experimental design. A good and appropriate design (like in building a house) gives you the needed latitude to manipulate one variable (mainly the IV or process factor), measure another (the DV or response variables), while controlling every others variables (EV or order effects).
Experimental Design

Generally speaking, some students arbitrarily develop a dislike or phobia for experimental research, especially when it get to experimental design, but the problem of these students is often based on poor foundation or poor intellectual ability, rather than on the difficulties of the design technique itself (Benjafield, 2013). Like a blueprint of a house, Experimental Design is the laying out of a detailed (experimental) plan in advance of doing the experiment. Hence, well chosen experimental designs maximize variability (changes) due to IV and minimize the variability due to extraneous variables. This refers to how subjects are assigned to the different (treatment) conditions (also called IV groups) in an experiment. An experimental design must, therefore, take into account the population, sampling method, participants/subject. It must be noted here that randomization or group assignment (made of experimental group and the control group), is not the same as random selection. When a scientist uses the word population, he or she refers to a large collection of individuals, subjects or participants that are the main focus of a scientific query. In the experiment, "The effect of violent television movies on aggressive behaviour in Nigeria." the (benefiting) population is Nigeria. From the population, the researcher selects research subjects, which are individuals or nonhumans about whom the researcher (whether professional or student) is going use for experiment. Since it is naturally impossible for a researcher to involve all Nigerians in this research, he or she will follow a process called random sampling or random selection.

Random sampling is the process of selecting subjects/participants from a population of interest in such a way that the subjects will be the representation of the population. Strictly speaking, one does not select people at-will and call them research subject. No, there is rule and technique that governs how participants must be selected. For instance, while Nigeria is focal and benefiting population of the research, subjects/participants should fall within certain age range that is physically capable of watching a television and the ability to perpetuate violence. Here children (1-5 years) and older adult (90 and above) may be excluded from the research. There are many techniques of sampling, but the most important thing in any techniques used is that it must have a commensurate value in which every person in the population has a fair chance of been selected, and that the research subjects/participants are fair representative of the population of interest (Pashler, 2002).

It is always important to distinguish between subject selection and random sampling and between group assignment and randomization. As we stated above, random sampling is one of the techniques researchers use to select research subjects or participants from population. Group assignment, on the other hand is an experimental design aimed at deliberately allocating subjects or participants to groups. Since the reliability and validity of a true experiment depend on the strength of control an experimenter builds into the design, many experts believed that experimental design is the most important part of scientific method (Xu, Yang, Abula & Qin, 2013). Therefore, an experimental design can be defined as a set of procedures used to control
the influence of "irrelevant" variables or factors on the outcome of empirical observations of actions, thoughts, behaviour of humans or animals used as participants or subjects (Solso & Johnson, 1998). There are many types of experimental designs, but the most important characteristics of all is that it must not only have the tendency to show a causal relationship between independent and dependent variables, but must also show that the relationship is generalizable to the whole population or circumstances. This is to say that while choosing an experimental design, the basic questions a researcher must answer are:

- Is there a relationship between the independent and dependent variables? If yes,
- Is the relationship causal in nature?
- Can this relationship (between IV and DV) be generalized to the whole population, settings, times, and operations?

When your research design answers and justifies the first two questions, it is said to have **internal validity**. It is said to have **external validity** to the degree that it produces an accurate answer to the third question.

**Application of research designs in Experiments**

As illustrate in figure 2, let us say you became worried about sudden increase in violence and aggressive behaviour in Nigeria, and in your curiosity you wanted to find why the sudden increase. In your observations and questions, you discovered that young people spent a great deal of their time watching violent movies. You then hypothesized that "watching violent movies could cause aggressive behaviour." This is only a hypothesis, not scientific empirical finding. But to arrive at a scientific finding, you must subject your hypothesis to a test. To do this, you must design an experiment around your hypothesis, under which careful and meticulous observations will be made. You may need (specialized) instruments or appliances, controlled environment (laboratory or a place arranged to mimic laboratory conditions), and participants/subjects sampled for the experiment. So, in order to formulate a good experimental design, it must have the following features: ability to manipulate events (showing causal relation between violent and aggression); Controlled environment (excluding other events that might induce violence or aggression); identify threats to internal and external validity of your design, and empirical measurements (participants' behaviour characteristics are determined before and after movies). Group assignment (treatment in experimental research) is essential part in manipulating the research independent variable (Sturm & Ash, 2005).

**Figure 2: The effect of violent television movies on aggressive behaviour in Nigeria**

<table>
<thead>
<tr>
<th>Population</th>
<th>Sampling</th>
<th>Participants/Subject</th>
</tr>
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<tbody>
<tr>
<td>Draw a sample from Population to get your Participants or Subjects. There are many ways of sampling.</td>
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Non-experimental Approaches

Again, the choice between the experimental and non-experimental approaches is generally dictated by the nature of the research question. If it is about a causal relationship and involves an independent variable that can be manipulated, the experimental approach is typically preferred. Otherwise, the non-experimental approach is preferred. However, the two approaches can also be used to address the same research question in complementary ways. For example, non-experimental studies establishing that there is a relationship between watching violent television and aggressive behaviour have been complemented by experimental studies confirming that the relationship is a causal one (Price, 2016).

For example, in our television viewing experiment, the participant/subjects are randomly assigned to four groups, and each group is 'treated' with a different types of violent and non-violent movies to see which produces the most aggressive behaviour. Treatments are administered to experimental groups by 'level', where level here implies amount or magnitude. For example, if the experimental group were shown high-impact violent movie, moderate-impact violent movie and low-impact violent movie, those would be three levels of the treatment. It is the experimenter that sets the levels of a given independent variable and also determines the appropriate control for a given experiment. In each of the groups, you may revise the level of
movies shown to different treatment groups. This technique is called **counterbalancing** (Brooks, 2012).

### Some Valuable Psychology Experimental Instruments

As stated above, from the time of scientific revolution till present day, psychology had competed with other "true" experiment-based sciences, like physics, chemistry, biology, etc., and had fought to distinguish itself as a formidable discipline that bases its findings on scientific principle and laws. Apart from its compliance to scientific methods and experimental principles, it had, from onset, established "laboratories, equipment, subjects, experimental techniques, statistical analysis upon which conclusions are based (Solso & Johnson, 1998, p.3)."

Even presently, psychology experimental laboratory and equipment are becoming dazzlingly sophisticated with specialized computers, physiological instruments and all sort of scientific gadgets that only but an ignorant critique will continue to doubt psychology's place in natural sciences (Solso & Johnson, 1998). And the Instruments used in experimental psychology evolved along with technical advances and with the shifting demands of experiments (Berkowitz & Donnerstein, 1982).

Some of the earliest and present instruments include:

**Hipp chronoscope / Chronograph**

The Hipp chronoscope is one of the most important scientific instruments of late 19th and early 20th century psychology, and was used around 1850. It uses to measure reaction time, with a vibrating reed that indicates time in 1000ths of a second. Originally it was designed for experiments in physics, it was later adapted to study the speed of bullets (Sturm & Ash, 2005). When psychology was under physiological sciences, it was used in psychology to study and measure reaction time and the duration of mental processes.

Following a lead from a English physicist Charles Wheatstone (1802 - 1875), the German clockmaker and mechanic Matthäus Hipp (1813 - 1893) presented his version of this electromagnetic precision timer in 1848. After Wilhelm Wundt (1832 - 1920) recommended the application of Hipp's chronoscope in the first edition of his path-breaking text book *Grundzüge der physiologischen Psychologie* in 1874, the "time viewer" was widely used in the emerging community of experimental psychologists.

The Control Hammer Apparatus was introduced later for calibrating and monitoring the validity of Hipp-chronoscope. It consists of a **bent lever** whose arm is heavily weighted and turns about a horizontal axis. As the hammer-head descends, a cross bar on the shank makes or breaks the contacts. The control time is varied by shifting the counterweight on the short arm of the lever. Every psychological laboratory had some form of control instrument for calibrating the Hipp
Chronoscope. There were three varieties of control instruments: the Gravity Chronometer, the Pendulum Chronometer and the Hammer Apparatus. Researchers used control instruments to generate a known and constant period of time; a mass fell through a measured distance, making and breaking currents at the beginning and end of the course. The control instrument was the fundamental timing device of the laboratory upon which all timing calibrations relied. According to Titchener (1905; 1915), proper use of control apparatus depended on a good amount of precision, constant oversight, and mastery of operation. Experienced researchers tended to use complex control apparatus, while less experienced undergraduates used primitive, simpler instruments. Wundt’s famous Hammer Control Apparatus, for example, could only be used by a select group of people.

A reaction-time experiment, using a Hipp Chronoscope and a Cattell Gravity the Gravity Chronometer, the Pendulum Chronometer and the Hammer Apparatus Chronometer, much like those that Cattell and his students regularly performed at the University of Pennsylvania. (For details, see M. M. Socal, "An education in psychology," p. 323.) The time taken for the subject to begin reading a word displayed in the chronometer, at left, is being determined. The Hipp chronoscope is started by the dropping of the screen. It is stopped by the subject reading the word aloud, which opens the lip key in the subject's mouth.

**Operant conditioning chamber**

An operant conditioning chamber (also known as the Skinner box) is a laboratory apparatus used to study animal behaviour. The operant conditioning chamber was created by B. F. Skinner,
while he was a graduate student at Harvard University. It is used to study both operant conditioning and classical conditioning. It is often sound-proof and light-proof to avoid distracting stimuli. Skinner considered free will an illusion and human action dependent on consequences of previous actions. If the consequences are bad, there is a high chance that the action will not be repeated; if the consequences are good, however, the actions that led to it will become more probable. Skinner called this the principle of reinforcement. Skinner called the use of reinforcement to strengthen behaviour operant conditioning, and he considered the rate of response to be the most effective measure of response strength.

Lab Rat Cage and Rake
We pointed out that the use of animals as research subjects has been part of experimental psychology since the early 1900s. Animal houses and cages containing these animals have also been part of laboratory equipment. Caging System for mice has been one of the prominent one, and consists of high-performance racks that is design rats or ed to house single-use, disposable cages. It is constructed to have lids, feeders, watering solutions, and accessories fit the same easy access, manipulation and maintenance of subjects. Modern cages and their rakes are irradiated bottom (base) for added biosecurity, and stack compactly to maximize material handling and storage efficiency.
Stereoscope

The first stereoscope was invented by Wheatstone in 1838. It presents two slightly different images, one to each eye, at the same time. Typically the images are photographs of the same object taken from camera positions that mimic the position and separation of the eyes in the head. When one looks through the stereoscope the photos fuse into a single image that conveys a powerful sense of depth and solidity.
Stereoscopic vision or Stereopsis (from *stereo* meaning solidity, and *opsis* meaning vision or sight) is the process in visual perception leading to perception of stereoscopic depth. In turn, stereoscopic depth is the sensation of depth perception that emerges from the fusion of the two slightly different projections of the world on the two retinas. The difference between the two eyes’ images, which is a result of the eyes’ horizontal separation, is usually referred to as binocular disparity or retinal disparity. The fact that this binocular disparity is interpreted by the brain as depth was first discovered by the English genius Charles Wheatstone and described by him in a classic paper published in 1838: the mind perceives an object of three-dimensions by means of the two dissimilar pictures projected by it on the two retina, (Wheatstone, 1838). To prove his ideas Wheatstone invented a simple device, which he dubbed a stereoscope. Using his newly invented stereoscope Wheatstone was able to convincingly show that a vivid sense of depth emerges from two completely flat pictures depicting two different projections of the same scene.

**Kymograph**
Developed by Carl Ludwig in the 19th century, the kymograph is a revolving drum on which a moving stylus tracks the size of some measurement as a function of time. The kymograph is similar to the polygraph, which has a strip of paper moving under one or more pens. The kymograph was originally used to measure blood pressure and it later was used to measure muscle contractions and speech sounds. In psychology, it was often used to record response times. Psychologists first used kymographs for recording blood pressure. Experimental psychologists adopted the kymograph as an instrument for recording various time-related events: response times, stimulus presentations, muscle exertion and tuning fork vibrations. The preparation of smoked paper, an art in itself, consisted of placing a blank sheet of paper over a stand and exposing it to petroleum lantern fumes. The experimenter then wrapped the smoked paper around the drum. The signal maker would contact the drum as it rotated, leaving a line record. Following the recording, the experimenter varnished the paper for permanent keeping. Two of August Kirschmann’s students at the University of Toronto refer directly to one of the earliest horizontal kymographs used in the laboratory, in a study on the estimation of time intervals.
**Stereotaxic Apparatus**: Stereotaxic apparatus is like a restrain used to examine the effect of stimulating or destroying these neural regions in the rat's brain. As a means of restrain, the researchers clamp the rat's head into a **stereotaxic apparatus**, making certain that the electrode is in the right location.

![Mechanical sketch of Stereotaxic Apparatus](image)

**Photokymographs**

This is the oldest type of camera used as a device as a photographic recorder in laboratories, which was famous in psychology laboratories. It used mirrors and light to record the photos. Inside a small box with a slit for light are two drive rollers with film connecting the two. The light enters through the slit to record on the film. A camera having a narrow slit and cylindrical lens, and an arrangement by which photographic paper or film may be made to pass at a controlled rate across the opening; a beam of light projected upon the slit casts shadows of moving pointers, etc. or of the string of a string galvanometer, upon the sensitive surface, the movements of these shadows being photographically recorded - from Warren's Dictionary of Psychology. Some photokymographs have a lens so an appropriate speed for the film can be reached.
Photokymographs
**Galvanometer**

The galvanometer is an early instrument used to measure the strength of an electric current. Hermann von Helmholtz used it to detect the electrical signals generated by nerve impulses, and thus to measure the time taken by impulses to travel between two points on a nerve.

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**Audiometer**

This apparatus was designed to produce several fixed frequencies at different levels of intensity. An electronic device used to measure auditory sensitivity, usually in medical or clinical settings. Its primary use is to produce an audiogram of the person's hearing. It could either deliver the tone to a subject’s ear or transmit sound oscillations to the skull. An experimenter would generally use an audiometer to find the auditory threshold of a subject. The data received from an audiometer is called an audiogram.
The first widely-used audiometer was the Western Electric 2A audiometer (1923). It ran on dry cells and was designed to meet clinical needs. In the early instruments, normal threshold values for each test frequency had to be established first to provide a reference. The instrument was limited to 8 frequencies at octave intervals between 64 Hz and 8,192 Hz. The intensity range was limited, and an additional booster amplifier was needed to determine the threshold of feeling.

Colorimeters
Colorimeters are tristimulus (three-filtered) devices that make use of red, green, and blue filters to emulate the response of the human eye to light and colour. In quality control applications, these tools offer an excellent price/value relationship.

Colorimeters provide users the ability to emulate how a physical product will appear. These determine the colour composition by measuring its tricolour characteristics or matching of a colour sample. This type of device would be used in visual experiments (Stevens, 1951).

A simple colorimeter is described which enables untrained observers to rapidly and reliably match hue and saturation using a novel joystick control. The colorimeter output is suitable for computer recording and analysis. The applications of this colour-matching technique in experiments requiring speed and simplicity are illustrated.
Algesiometers and Algometers

Both Algesiometers and algometers are mechanical stimulations of pain. They have a sharp needle-like stimulus point so it does not give the sensation of pressure. Experimenters use these when doing an experiment on analgesia (Benjafield, 2013).

Old Model

Newer Model

Olfactometer

An olfactometer is any device that is used to measure the sense of smell. The most basic type in early studies was placing a subject in a room containing a specific measured amount of an odorous substance. More intricate devices involve some form of sniffing device, such as the neck of a bottle. The most common olfactometer found in psychology laboratories at one point was the Zwaardemker olfactometer. It had two glass nasal tubes projecting through a screen. One end
would be inserted into a stimulus chamber, the other end is inserted directly into the nostrils.

**Sonometer**

A sonometer is an apparatus made of a hollow box having two holes. A string is attached to it by which the transverse vibrations of strings can be studied. It is also called the monochord because it often has only one string.

**Mazes**

Probably one of the oldest instruments for studying memory would be the maze. The common goal is to get from point A to point B, however the mazes can vary in size and complexity. Two types of mazes commonly used with rats are the radial arm maze and the Morris water maze (Meyer & Quenzer, 2005). The radial arm maze consists of multiple arms radiating from a
central point. Each arm has a small piece of food at the end. The Morris water maze is meant to test spatial learning. It uses a large round pool of water that is made opaque. The rat must swim around until it finds the escape platform that is hidden from view just below the surface of the water. There are three types of maze: Complex, simple and radial.

**Electroencephalograph (EEG)**

An **electroencephalogram** (EEG) is a test that detects electrical activity in your brain using small, flat metal discs (electrodes) attached to your scalp. Your brain cells communicate via electrical impulses and are active all the time, even when you're asleep. This activity shows up as wavy lines on an EEG recording. It reflects the summed electrical activity of neural cell assemblies in the brain, and was originally used as an attempt to improve medical diagnoses. Later it became a key instrument to psychologists in examining brain activity and it remains a key instrument used in the field psychology, especially neuropsychology) today. During the test, small sensors are attached to the scalp to pick up the electrical signals produced when brain cells send messages to each other. These signals are recorded by a machine and are looked at by a
doctor later to see if they're unusual. The EEG procedure is usually carried out by a highly trained specialist called a clinical neurophysiologist during a short visit to hospital.
**Functional Magnetic Resonance Imaging (fMRI).**

The fMRI is an instrument that can detect changes in blood oxygen levels over time. The increase in blood oxygen levels shows where brain activity occurs. These are rather bulky and expensive instruments which are generally found in hospitals. They are most commonly used for cognitive experiments. **Functional magnetic resonance imaging or functional MRI (fMRI)** is a **functional** neuroimaging procedure using **MRI** technology that measures brain activity by detecting changes associated with blood flow. This technique relies on the fact that cerebral blood flow and neuronal activation are coupled.

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**Positron emission tomography (PET)** is a test that uses a special type of camera and a tracer (radioactive chemical) to look at organs in the body. The tracer usually is a special form of a substance (such as glucose) that collects in cells that are using a lot of energy, such as cancer cells. PET is also used to look at the brain. It can detect drugs binding neurotransmitter receptors in the brain. A down side to PET is that it requires radioisotopes to be injected into the body so the brain activity can be mapped out. The radioisotopes decay quickly so they do not accumulate in the body.
It uses a special type of camera and a tracer (radioactive chemical) to look at organs in the body. The tracer usually is a special form of a substance (such as glucose) that collects in cells that are using a lot of energy, such as cancer cells'

**Institutional Review Board (IRB)**

In the United States and Europe, Institutional Review Board (IRB) plays an important role in monitoring the conduct of researchers in psychological experiment, especially as it involves humans and animals. Their presence is required by law at institutions such as universities where psychological research is conducted. The IRB comprises experts in scientific experimental methods and bioethics, whose purpose is to assure that researchers (both lecturers and students) do not violate ethical codes or legal requirements (APA 1987). Thus the board protects human subjects from physical or psychological harm, assure the humane treatment of animal subjects and prevent deception, forgery and plagiarism in research. An IRB must review the procedure to be used in each experiment before an experimenter commences research. The IRB also assures that human participants give informed consent in advance; that is, the participants are told the general nature of the experiment and what will be required of them. There are three types of review that may be undertaken by an IRB - exempt, expedited, and full review. More information is available on the main IRB page (Bronte-Tinkew, Allen & Joyner, 2008).

**Conclusion**

Our aim in this article is to underscore the place of psychological experimental research, either as a laboratory procedure or scientific enquiry follow rigorous scientific methodology. As the processes of acquiring knowledge under intuition (based on preconscious processes), authority (i.e., based on what experts say), rationalism (i.e., based on reasoning), and empiricism (i.e., based on experience), expand (Sowa, 1984), science becomes a very special thought process that is regarded as the most trustworthy way of acquiring reliable and valid knowledge about the natural world(Swigler, 1992; Fraisse, Piaget & Reuchlin, 1963). However emphasis on verificationism (verifying hypnosis) and falsificationism (attempting to falsify hypotheses) have become major approach in science, with the definition of science as the preferred way of acquiring reliable and valid knowledge about the natural world, one sees science as the "true" methods for obtaining scientific knowledge, standards for judging whether the knowledge is warranted or justified, as well as a set of facts and theories constituting the current what our world really is (Hergenhahn, 2009). This fact is based on the primary assumptions of science, which state that a) there is orderliness and regularity in nature, b) what we call nature is real including our experiences of it, and c) humans can discover regularities and pattern in nature.
The characteristics of science that make it possible for us to infer a more realistic validity and reliability of occurrences in our world (West & Thoemmes, 2010), are the fact that science and scientific methods can be:

- controlled (enables the scientist to identify causation),
- operationalised (researchers must clearly represent constructs in order of measurability), and
- replicate (findings results across multiple studies show the same results) (Berkowitz & Donnerstein, 1982).

Theory is part of science and science is part of theory. So, science continually moves back and forth between theory discovery and theory testing (or induction and deduction). As indicated in the rules of experimental psychology, scientists should be curious, must have patience, must try to be objective, and must be open to change (Liszka, 1996). The four major objectives of psychological research are description, explanation, prediction, and control or influence. Pseudoscience, like superstition, is a set of beliefs or practices that claim scientific status but are not scientific. The mantle of a scientist is to maintain an open mind, never becoming rigid in orientation or in method of research. This is because such rigidity could cause him or her to become blinded and incapable of capitalizing on, or even seeing, unusual events. However, the Nigerian environment is saturated with pseudoscience, which often infiltrates into the classical science, thereby confusing situation and making knowledge and practice of science redundant and unprogressive.

Reference

American Psychologist, 57, 646-653.


