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'I have faith in science and in God': common sense, cognitive polyphasia and attitudes to science in Nigeria

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‘I have faith in science and in God’: Common sense, cognitive *polyphasia* and attitudes to science in Nigeria

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Abstract

This study, of modern common sense in Nigeria, combines questionnaires and interviews to examine the compatibility and incompatibility of religion and science. Nigeria is a large country with a complex diversity of religious, ethnic and cultural practices that condition the reception and elaboration of science in everyday life. We find evaluative attitudes to science structured as 'progress', 'fear' and 'mythical image'. Scientific knowledge and religiosity have a direct bearing on expectations of progress and feeling of fear and worry about science; mythical image is independent of this. Nigerians trust both scientific and religious authorities in contrast to other social actors. Many of the results are consistent with the hypothesis of cognitive *polyphasia* of scientific and religious knowing manifesting as a 'hierarchy', when one form is elevated over the other; 'parallelity', when both serve separate functions; and 'empowerment', where one enhances the other.

Keywords

attitudes, faith, interaction, cognitive polyphasia, religion, science, trust

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> We want it all. We want to cheer on science's strides and still humble ourselves on the Sabbath. We want access to both Magnetic Resonance Imaging (MRI) and miracles (Cray, 2006).
>
> 'Should I say God does not teach us to be foolish' (Interview participant).

Introduction

In 2003, the Supreme Council for Shari'ah in Nigeria (SCSN) intervened to stop an ongoing national immunisation campaign. This was the climax of a dispute over scientific findings on a suspected contamination of the oral polio vaccine (OPV) being administered nationwide by sterilising substances, suspicions of the intentions of the Western sponsors of the programme and campaigns by Muslim clerics that vaccination is against Islamic injunctions (Atofelekun, 2001; Madugba, 2003). The revolt created an image of religion that is anti-science.

The reversal of policy from acceptance to rejection (Ogundipe, 2004) – following the change of government in Kano State, North West Nigeria, from the religiously liberal People's Democratic Party to the more conservative All Nigeria's People's Party – also supports arguments for the mediating effect of religion on science policy. Such mediation is, however, not limited to developing countries. Mooney (2005) describes Presidents George W Bush and Ronald Reagan as waging a 'republican war on science'.

A poll of 10 countries (BBC, 2005) shows that 95% of the population of Nigeria, 67% of the United States and 28% of the United Kingdom pray regularly. Another poll, the World Values Survey (2015) shows that 40% of respondents in the United States agree that

'Whenever science and religion conflict, religion is always right', 15% agree in Germany and 88% in Nigeria. Such levels of agreement provide plausible evidence for the prominent role of religion in democratic governance and science policy.

The OPV revolt may be seen as religion resisting science; but we take a different approach in this study, the first of its kind, to instead explore how science changes common sense under the public understanding of science paradigm, where researchers have over the years focused on the relationship between knowledge, evaluative attitudes and intervening variables (Bauer et al., 2007; Bauer and Falade, 2014). We focus here on the role of religiosity as a mediating variable and hope this study will provide a platform for the development of a science culture index for Africa which considers religious, regional and political identities.

The Nigeria context: politics, religion and science

The International Crisis Group (ICG, 2010) notes that while there is admiration for science in the country, there is also apprehension about Western culture and Muslims view international affairs as a subtle but continuous conflict between the Judeo-Christian West and the Arab-centred Islamic world. Also, Paden (2005) notes that secularism is a minority perspective in Nigeria, and strategic to its stability will be a political system that recognises and balances ethno-religious and regional diversity. Paden's views reflect the current political structure where all political offices including that of the president and his vice are rotated and distributed among the tribes, the regions and main religions making ethnic and religious identities political qualifications.

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At present, Northern Nigeria is predominantly Muslim, while the south is Christian, and both faiths have injunctions guiding adherents on illness and financial wellbeing. The drama at the 'Okija shrine' (spiritual political and financial power) and the reign of the 'Bakassi Boys' (vigilante justice) in the South and the activities of the 'Mai Bori' (traditional medicine practitioners) in the North also show that African knowledge coexists with scientific and religious practices (Anderson, 2002; Ellis, 2008; Smith, 2004). Also, the Christians are formed of many sub-groups such as Catholics, Protestants, Pentecostals and White Garments; the Muslims comprise Shiite, Sunnis, Sufi, Ahmadiyya, and so on, while the traditionalists include the Osun Oshogbo, Okija, Yemoja, Ogun and Sango followers.

The place of religion in society has tasked scientists for centuries; it has divided the political class and appears to separate Europe from the rest of the world (Habermas, 2006). The issues have recently resurfaced in the guise of New Atheism in the Anglo-Saxon world. Cray's (2006) citation above was from a debate between two renowned scientists, Professor Francis Collins and Professor Richard Dawkins. Dawkins argues that a supernatural creator almost certainly does not exist while Collins sides with the evolutionary theorists and also embraces the existence of God. In Nigeria, religion, both Western and African, has a strong influence in the public sphere affecting the uptake of both political ideas and scientific innovations.

The transformation of the unfamiliar

Knowledge, evaluative attitudes, religiosity and trust

Surveys have been held in many countries to see if there is a correlation between knowledge and evaluative attitudes to science. But such surveys have been interpreted as the 'cognitive deficit approach' which contrasts scientists against less informed lay people (Wynne, 1982; Ziman, 1991). Bauer et al. (2007) suggested a reframing of the knowledge-attitude problem recognising that information matters not only as the ability and motivation to process it (see also Sturgis and Allum, 2004), but also as a marker of quality of the attitude. Reviewing 193 surveys from 40 countries, Allum et al. (2008) found a small but positive correlation between general attitudes and general knowledge of science after controlling for a range of variables.

Religion used to perform the symbolic function of providing familiar terms to cope with the unfamiliar but in modern society, the term 'risk' acknowledges that unexpected results may be a consequence of our own actions and not a design of the gods (Luhmann, 1998). This transformation of historical semantics (from a closed cosmos to the open infinite space of modern science) does not advance or disadvantage the course of religion, but adds another meaning to human experience. Luhmann proposes that trust in a cosmos or in science is only required if a bad outcome would make one regret a decision. For Giddens (2002) while risk is part of the dynamics of capitalist societies, others, continue to use fate, luck or the will of the gods (or God).

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Trust is an actor's belief that at worst, others will not knowingly or willingly do him harm, and at best they will act in his interest (Newton, 2001) and is what derives from faith in the reliability of a person or system (Giddens, 2002). Trust is crucial to social and societal functioning (Twenge et al, 2014); key to cooperation in situations of conflict (Balliet and Van Lange, 2013) and sensitive to ethnic diversity (Putnam, 2007). It is also important when familiarity is low as it compensates for deficiencies on the cognitive level (Nisbet and Scheufele, 2009; Siegrist et al, 2005; Neidhardt, 1993). Now science is far from unanimous and it is possible for all sides in a controversy to provide conflicting evidence (Lidskog, 1996). Controversies are also amplified by powerful technological and social changes that systematically destroy trust and are increasingly being seen as side effects of our participatory democracy (Slovic, 1999). As science becomes more complex and familiarity levels dip, we have to increasingly trust persons and institutions as regards possible risks. Nigeria is a multi-ethnic and multi-religious country and this may affect trust levels between the different groups.

The OPV controversy shows the role of conflicting scientific evidence and party democracy in intensifying conflict and that religion may intervene in situations of risk. In the controversy, God was both the causative and curative agent for some believers (Falade, 2014) and understanding this was crucial to disease containment. The public can also be unfamiliar with new diseases (HIV, Severe Acute Respiratory Syndrome, Ebola and Zika) and public education becomes important.

Science, religion and cognitive polyphasia

Durkheim (1912/2001) argues that faith in science is not necessarily different from religious faith and if the transformation from a closed and populated cosmos to an infinite and cold space of science adds another dimension to human experience instead of substituting one form of faith by another, then faith in science and religion will likely coexist until all cosmology is transformed. It was Durkheim's belief that, as individuals become less dominated by the collective, scientific representations will replace non-scientific beliefs. Lucien Lévy-Bruhl, was by contrast, convinced that scientific thought would not replace pre-scientific thoughts – the law of non-contradiction does not eliminate the law of participation (Moscovici, 2000). Lévy-Bruhl's position, Moscovici argues, continues to illuminate why scientific concepts are accommodated into common sense rather than simply displacing older ideas. The positivist ambition of old and new Atheists, a common sense cleansed of all religious content, is unlikely to be borne out by empirical reality.

The thesis of cognitive *polyphasia* proposes that in any one person's mind, science and other forms of knowledge can coexist as 'a plurality of modes of thought' shared as common sense (Moscovici, 1991/2014; Bauer and Gaskell, 2008). Just as some people can master different languages without confusion (being polyglot), many others can handle different modalities of knowledge (being polyphasic) without feeling contradictory and therefore agitated. Analogous to research on multilingualism, research into cognitive *polyphasia* needs to explore the varieties of co-existence between different forms of knowing in everyday life. In many societies, cognitive *polyphasia* – the diversity of forms of thought – is the rule, not the exception (Jovchelovitch, 2008) and indeed Shein et al (2014) found the

coexistence of high scientific enculturation and pseudo-scientific beliefs and fortune-telling practices in Taiwan, in particular among the educated younger generation.

Festinger's theory of cognitive dissonance (Festinger, 1962) argues that people experiencing contradictions in themselves are always motivated to resolve it and substitute one thought content for a 'superior' one. Billig (1987), however, contests this arguing that people are far more tolerant of cognitive and interpersonal inconsistencies than the dissonance theory assumes; its universality is claimed rather than proven

Research Questions

Based on our above considerations of the problem of the perennially unfamiliar in society and the notions of cognitive polyphasia in Nigeria with regard the resources of dealing with the unfamiliar, we formulate the following research questions on the relationship between traditional, religious and scientific forms of knowing.

RQ1. Is cognitive *polyphasia* evident in the compatibility and incompatibility of peoples' interests, informedness and engagement with science?

RQ2. Is cognitive *polyphasia* evident in the compatibility of modern and traditional forms of knowing?

RQ3. Is cognitive polyphasia evident in the correlation pattern of trust in different actors?

RQ4. Can we demonstrate cognitive *polyphasia* in the interaction effects of scientific knowledge and religion when considering evaluative attitudes to science?

RQ5. Can we further specify cognitive polyphasia by distinguishing qualitatively different ways of relating to both science and religion simultaneously?

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Data and Methods

This study adopted a triangulation of methods using questionnaire survey and qualitative interviews, in search of an enhanced understanding (Flick, 1992) and to check single methods myopia (Denzin, 2010). A questionnaire survey with 74 items was administered in Lagos State for three weeks in November 2012 (N = 377; error margin = 5%). Lagos is Nigeria's economic capital with a population estimated at 9.1 million by the 2006 federal census (NPC, 2013) and projected to be about 13 million in 2012. A stratified convenience sample of respondents was collected using a network of volunteers in targeted locations such as offices, clubhouses, group meetings, mosques and churches. Volunteers were chosen because of their access to these specific social clusters and were given some quota guidance. It was part of a larger study which involved media mapping, surveys and interview data (Falade, 2014 and 2016). Most of the 74 questionnaire items were adopted from similar surveys in the European Union (EU, 2005) and by the National Science Foundation in the United States (NSF, 2014).

Indicators of the six key concepts were constructed: interest and being informed, engagement, trust, knowledge and evaluative attitudes. For knowledge, we used a summative scale of items and for trust and evaluative attitudes, we computed the scores arising from exploratory factor analysis. The sample size of 377 was sufficiently large to result in stable factor solutions: Kaiser-Meyer-Olkin (KMO) = 0.6 for trust and 0.7 for attitude items. We used Principal Component Factor Analysis (PCFA) to identify the latent structure of items and rotated the solution with Promax Kappa 4 (Fields, 2005). The resulting set of indicators is the basis of the analysis.

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In the analysis of evaluative attitudes, we used religion as an intervening variable after controlling for age and sex. Respondents were asked: *"How much guidance does religion play in your life"* on a scale of zero to six (6 = total guidance). Overall 95% of respondents declare taking religious guidance. The variable was then grouped into weak (24%), strong (25%) and very strong (48) religiosity. To examine the relationship between religiosity, knowledge and evaluative attitude facets, we used multivariate analysis of variance (MANOVA); SPSS was used for all statistical analyses.

In addition, fifteen qualitative interviews were conducted in Lagos in September 2012 but before the main survey in November 2012. The episodic interview format (Flick, 2000) adopted was to allow participants to narrate personal experiences with science and religiosity and how these have shaped their views and actions. The interviewees were also presented with findings of the pilot online survey conducted earlier in May 2010.

Limitations

Although Lagos is a cosmopolitan centre, the conclusions from this survey cannot be generalised to the whole country without a proviso. A national interpretation would require a stratified random sample design that covers the whole country. The present sample shows a cosmopolitan bias which is reflected in education and gender ratios. Being cosmopolitan however, has its convenience: all tribes and religions are represented in public and private institutions and gatherings, hence the targeting of offices and social events. Of the current respondents, 55% are, however, from the South West; 13% from the North; 11% from the South South; and 14% from the South East. This is clearly not a representative sample of the country. There were more females (54%) than males in the sample. On age, (<29, 28%; 30 to

39, 26%; >40, 32%) and education, the urban population was fairly well represented; most respondents (85%) had been educated above secondary level, enough to read a newspaper. Thus, our sample represents an urban Nigeria. In the absence of any other data of this kind for Nigeria, the study functions as a baseline for future research.

Cognitive Polyphasia evidence in the survey data

We examined evidence for cognitive polyphasia on several dimensions of people's relations to science and religion. We examined interest, being informed and engaged, being familiar and knowledgeable, trust in various actors, and the interaction effect of religion and knowledge when predicting evaluative attitudes to science.

Interest, being informed and engagement

Respondents were asked how interested or informed they were about certain issues: *In everyday life, there are a lot of issues in the news and it is hard to keep up with every area. I would like you to tell me for each of the following issues how interested (or informed) you feel you are?* The options were: *Very interested; Moderately interested; Not at all interested and Don't Know*. Very and Moderately (interested or being informed) were summed up as interest (or being informed).

Nigerian respondents feel less informed (63%) than they are interested (73%) in new scientific discoveries, ditto new medical discoveries. Levels of interest in new scientific discoveries were lower than in the EU (78%) and USA (85%). In the EU, respondents also feel less informed (61%) than interested. Nigerian respondents also feel more interested than

informed on other issues (religion, current affairs, entertainment, sports and culture) except politics, where information (74%) seems to exceed common interest (69%).

Respondents were also asked how they engaged with science and religion: *We would like to know how regularly you engage with science, technology and religion*. The options were: *Daily; Weekly; Monthly; Once or twice a year and Never*. A minimum of once a month was regarded as engagement. The results show that while 70% pay attention to science (i.e. they report reading and watching science in the mass media), the figure dropped to less than 20% when we asked about attending science events, activities and even sponsoring science in one way or another. In contrast, 84% of the respondents read about and watch religious events; 91% attend religious activities; and 75% donate to religious causes. Clearly, religious engagement is much larger than scientific engagement in Nigeria.

If we consider the patterns of correlations between interest and being informed about different topics, we find some evidence of compatibility between science and religion. A cross tabulation (Interest in new scientific discoveries and Interest in religion) shows about 70% of respondents are moderately or very interested in both science and religion. 18% are not interested in science but interested in religion; and 3% are interested in science and not in religion. However, the alignment of interest is not statistically significant. People who are interested and feel informed about religion are not as much interested (or informed) in science ($r < 0.09$; $p > 0.089$). On engagement, however, there is evidence of compatibility. Those who donate to religious causes also donate to scientific charities mainly health related ($r = 0.24$; $p < 0.001$; $N = 361$), and those who read and watch scientific materials also read, attend and donate in the religious sphere ($0.16 < r < 0.20$; $p < 0.002$). We conclude in relation to RQ1

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that there is some evidence of polyphasia with regard to scientific and religious engagement but less so with regards to interest and being informed.

Science and religion: modern and traditional knowing

We asked questions about people's general enculturation with science, which is globally operationalised by a battery of quiz items (see Bauer and Falade, 2014; Pardo and Calvo, 2004); i.e. textbook statements that rated true/false, which then code as correct/incorrect (Table 1).

Table 1. Eleven science literacy quiz ordered by item difficulty expressed as the percentage of correct Reponses (N = 377).

	Scientific literacy	**Nigeria 2012**	**F1[a]**	**EU 2005**	**USA 2012**
1	Father's gene decides sex (true) (EU mother's gene, false)	70	0.51	64	63
2	Oxygen we breathe comes from plants (true)	69	0.45	82	
3	Continents have been moving for years (true)	58	0.55	87	83
4	Centre of earth is hot (true)	46	0.48	86	84
5	All radioactivity is manmade (false)	42	0.46	59	72
6	Electrons are smaller than atoms (true)	35	0.41	46	53
7	Antibiotics kill viruses as well as bacteria (true)	25	0.17	46	51
	Cronbach Alpha (7 items)	0.47			
8	**Humans developed from animals** (Science correct = 37; religion correct = 44)	37	0.51	70	48
9	**Science never understands human mind** (science correct = 23; religion correct = 54)	23	0.51		
10	**Universe began with big explosion** (science correct 20; religion correct = 42)	20	0.42		39
11	**God decides sex** (scientifically false = 13; religion correct = 75)	13	0.13		`
	Margin of error	+/- 5%		+/-1%	+/-3.3%

[a]F1 = factor scores for Nigeria 2012, using PCFA; KMO = 0.6; 19% of variance.

We computed an index of knowledge based on total number of correct answers for each respondent for the first seven items in the table. The items, 8 to 11 not included, have

dual significance, both scientific and religious. The variables *'The universe began with a big explosion'*, '*God decides sex'* and '*Humans developed from earlier species of animals'* have both scientific and religious interpretations in Nigeria. Pardo and Calvo (2004) observed that radioactivity may activate pacifist anti-nuclear values in Germany while in the Netherlands, the question about the origin of humans from earlier animals may have interference from Calvinist cultural values. Comparative data show that respondents in Nigeria (37%), Malaysia (17%), Russia (44%) and USA (48%) are comparatively less in agreement with 'Humans developed from animals' than those in Japan (76%), the EU (70%), India (56%) and China (66%) (MASTIC, 2008; NSF, 2014; Shukla and Bauer, 2007). Somewhat surprisingly, Nigerians more readily agree to '*Humans developed from animals'* (37%) than '*The universe began with a big explosion*' (20%). Cross-tabulation shows that 82% of respondents who subscribe to the statement '*Father's gene decides sex of child*' are also happy with '*God decides sex of the child*' (12% disagree and 6% don't know). These observations might serve as indicators of multiple rationalities at work without cognitive dissonance.

Other indicators of cognitive *polyphasia* are questions regarding health practices, both modern and traditional. While less than 18% '*read horoscopes*' at least once a month, 48% take '*total guidance*' from religion and 88% '*believe in destiny*'. We also asked for primary and secondary considerations for different health practices. When asked their '*first option for tackling health problems*', 55% of respondents selected Western medicine, 24% prayers and 6% traditional herbs. The '*second option for tackling health problems*' was more revealing: 34% selected prayers, 29% Western medicine and 20% traditional herbs. The results show that respondents consult science, religion and traditional medicine, albeit in different

orderings. In all, 12% of the respondents chose Western medicine as first and second options, 17% chose Western and traditional in that order; 25% chose Western and prayer; and 15% chose prayer and Western medicine. We can conclude with regards to RQ2 that there is evidence of widespread polyphasia in the compatibility of modern and traditional knowing with respect to reproductive knowledge and issues of health and illness.

Trust in institutions and actors

We asked questions about trust in several different institutions. '*Please tell me on a score of zero to six, how much you generally trust these institutions and the people who run them to tell the truth*'. Looking at the correlation of the responses, we found that trust in seven different actors should be split into three dimensions, each positioning towards different groups of actors.

Table 2. Structure matrix for trust items (N = 311). A PCFA rotated Promax Kappa 4 solution indicates three factors which account for 71% of the variance (KMO = 0.6; Bartlett's sphericity = <0.001; multi-collinearity = >0.00001).

Factors	**% trust (4 to 6)**	**I – Public sector**	**II - Independents**	**III – Cultural authorities**
Trust in military leaders	17	.829		
Trust in Judiciary	25	.788		
Trust in politicians	3	.605		
Trust in foreign NGOs	56		.913	
Trust in local NGOs	36	.450	.865	
Trust in religious leaders	52			.845
Trust in scientists and professors	48		.428	.842
Variance explained		36.2%	19.9%	14.5%
Cronbach's alpha	0.69	0.66	0.68	0.62

The first dimension, the 'public sector' factor, combines trust in public servants of the judiciary, the military and politicians; while the second factor, 'independents', pools foreign and local non-governmental organisations. The third factor combines trust in 'cultural

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authorities' among scientists, professors and religious leaders. Trust in scientists and professors also loads on independents and this may be because scientists are both domestic and foreign voices heard. It is the same for local NGOs variable which also loads on public service and may have been influenced by foreign funding partners. With regards to RQ3, on the basis of structural analysis, we conclude that the trust in scientific and religious actors are highly correlated in Nigeria and these cultural authorities are contrasted to public and international actors. Whoever trusts a religious leader in Nigeria, is likely to also trust a scientific expert ($r = 0.46$; $p < 0.001$) but unlikely to trust politicians and less likely the military and NGO's. The three dimensions have some correlations: those who trust scientists and religious leaders can also trust NGOs ($r = 0.34$; $p=0.001$), but trust less the public actors ($r = 0.20$; $p=0.001$).

Interlude: Structures of evaluative attitudes to science

People also relate to science with evaluation and a sense of judgement. We asked respondents the following attitudinal questions: '*Below are some statements made about science and technology, for each statement, please tell me if you agree or disagree with them'*. The response alternatives on all 13 items were: *Totally agree; Agree; Neither agree nor disagree; Disagree; Totally disagree; Don't know.*

Table 3. Structure of attitude items (N = 301) shows factor loading for three dimensions: Myth, progress and fear. The table also includes the basic percentages of agreement to these items for Nigeria, EU and the US. For the analysis, the 'don't know' responses were merged with 'neither nor'. A PCFA rotated Promax Kappa 4 reveals three meaningful dimensions of evaluative attitudes to science in Nigeria, accounting for 46% of the variance (KMO = 0.7; Bartlett's sphericity = P <0.001; multicollinearity = >0.00001).

Attitudes to science	% Nigeria 2012[a]	F1 Myth	F2 Progress	F3 Fear	% EU 2005	% USA 2004
S[b] & T[c] can sort out any problem	24	0.756			21	
S will give a complete picture of the universe	45	0.643				
Growth of S means that few control our lives	35	-0.594				

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New inventions will counter harmful ones	46	0.462			48	
Benefits of S are greater than harmful effects	61		0.691		52	
Scientists want life better for average person	74		0.633			
S & T are making our lives healthier	56	0.553	0.624			
S makes our lives easier and more comfortable	81		0.560		78	90
S will create more job opportunities	60	0.415	0.526		77	91
S makes our way of life change too fast	74		-0.449		60	51
S is responsible for most environmental problems	44			0.749	57	
The more I know about S the more worried I am	41			0.735		
Knowledge makes researchers dangerous	35			0.701	59	
Margin of error	+/-5%				+/-1%	+/-3.3%

[a]Percentage agree and totally agree
[b]S = science.
[c]T = technology.

The answers were recoded so that the high value represents a positive image and evaluation of science. We merged 'Don't Know (DK) and 'Neither Nor' responses into a middle category to preserve sufficient N. DK can mean many things: it can be a case of ambivalence, of true ignorance, or it can indicate that the response options are not exhaustive (Pardo and Calvo, 2004). We are for the moment ignoring that 'DK' responses and 'neither nor' are not equivalent.

Previous analysis often show two components of evaluating science and technology: Factor 1 which expresses expectations of progress and utility and a second factor which shows reservations on the basis of values that might be implicated (Gaskell, et al, 2010; Pardo and Calvo, 2002). Our analysis equally finds in Nigeria this duality of evaluation.

'Progress' (F2) combines positive experiences with general welfare expectations from science. This is indicated by a positive balance of science overall, and general expectations that science will improve our lives and create more jobs for the future. Note that Nigerians who believe in progress will reject the statement that *'Science makes our way of life change*

too fast'. Whoever believes in progress will be impatient with its arrival. We note that progress items such as creating more jobs and making life healthier are also related to the idealist myth of science (F1).

The component 'Fear' (F3) however, brings together items which express a degree of worry and concern about modern science and technology in society, as in *'The more I know about science the more worried I am*'. This component is consistent with what is internationally known as 'reservations' and is also expressed in agreements to statements such as '*Science and technology are responsible for most of the environmental problems we have today*' and is also captured in concerns about the perceived danger in the statement '*Because of their knowledge, scientific researchers have a power that makes them dangerous*'.

In addition to these two factors of evaluation, attitudes in Nigeria are also expressed in images about the nature of science and our analysis rightly separates this image component from evaluative statements. 'Myth of science' (F1) combines statements which bring to mind an idealist image of science and its capacities often found in philosophical justifications: *'Science and technology can sort out any problem'* (omnipotence); '*One day, science will be able to give a complete picture of how the universe works'* (approximation); *'New inventions will always be found to counteract any harmful effect of scientific and technological developments'* (self-repair). Note that Nigerians who subscribe to the 'Myth of science' reject a conspiratorial view of science as in '*the growth of science means few people will control the world*'.

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With this structural analysis, we propose that to characterise evaluative attitudes to science in Nigeria, we need at least three dimensions: belief in progress, fear and worry about science and an element of imagination - a mythical-ideal image of science.

Knowledge and evaluative attitudes in relation to religiosity

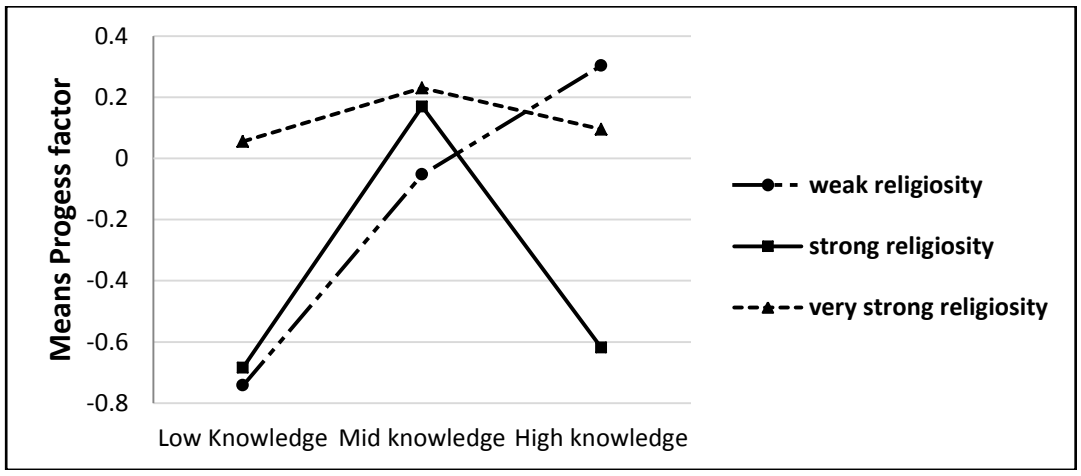
The relationship between knowledge and attitudes to science is generally expected to be a small, but positive correlation, unless the issue is highly controversial and at the peak of an issue cycle (Allum, et al, 2011). We are here dealing not with particular issues, but with general attitudes to science under normal circumstances of everyday life in Nigeria. In order to test the potentially complex relationship between knowledge, religion and evaluative attitudes to science, we conducted a MANOVA. This allows us to bring together all three facets of attitudes (myth, progress and fear) and to study the effect of enculturation with science in function of religiosity, controlling for age, education and sex. Religiosity and knowledge show complex interaction effects on expectations of progress and a sense of fear of science, but not on myths, *ceteris paribus*. None of the controls – education, sex or age – makes a direct contribution to any of the three facets.

Interaction of knowledge and religion on progress.

After controlling for gender, education and age of respondents, the main effect of knowledge remains in evidence ($F (2, 186) = 5.05$, $P = 0.007$, $eta^2 = 0.05$) for evaluating science as progress. Those who know more are more likely to have great expectations of science. The main effect of religiosity was also significant ($F (2, 186) = 4.54$, $P < 0.012$, $eta^2 = 0.05$). The more religious the respondents are, the higher the expectations. In addition, we observe an

interaction effect between knowledge and religiosity on progress ($F(4, 186) = 3.13$; $p < 0.016$; $eta^2 = 0.06$). Endorsement of progress is highest and independent of knowledge for very strong believers; for weak believers, endorsement of progress depends on knowledge; while for moderately strong believers, endorsement of progress is in evidence only with a medium level of knowledge (Fig. 1).

In conclusion, the relationship between enculturation of science and expectations of progress is different for different levels of religiosity. For the non-religious, more knowledge makes for greater optimism and for the very strong religious believers, knowledge makes no difference; they hold high expectations of science whatever the level of knowledge. For the category of moderately strong believers, which includes a high proportion of conventional churchgoers, as their knowledge increases, they become less optimistic in relation to progress and deviate from the opinions of either the non-religious or the very strong religious. The highly knowledgeable conventional churchgoers are more sceptical about science than everybody else.



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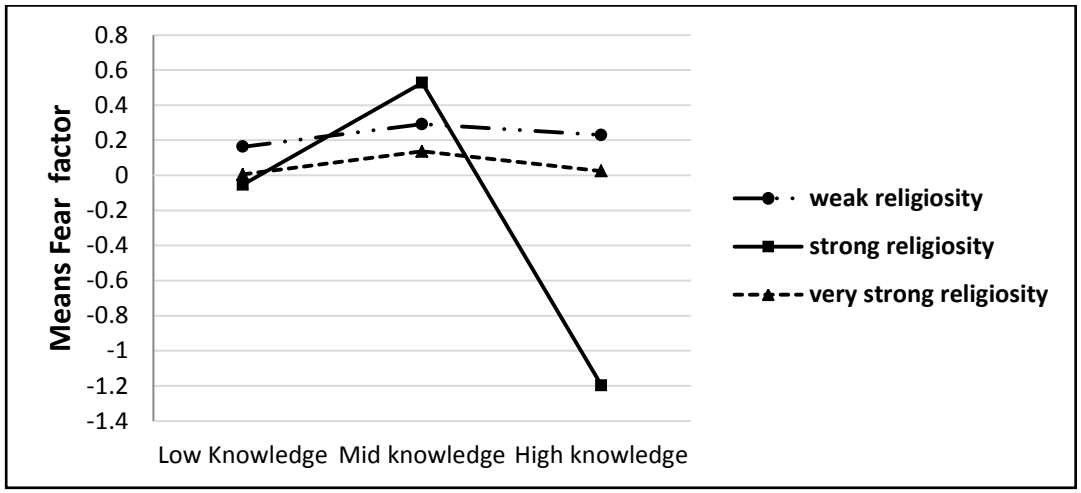

Fig. 1 Shows the result of the MANOVA for knowledge and religiosity on Progress factor (top) on fear factor (bottom). The graphs show the interaction effects of religion on the relationship between knowledge and evaluative attitudes [we had also included the facet image, but the results were not significant].

Interaction of knowledge and religion on fear

Again, as on progress, a main effect for religiosity on fear was in evidence ($F (2, 186) = 3.09$, $p < 0.048$; $eta^2 = 0.032$); the more religious, the less fearful with regards to science. And so was the gradient of knowledge ($F (2, 186) = 6.39$; $p < 0.001$, $eta^2 = 0.07$); the more knowledgeable, the less worries about science. As with progress, we find a complex and rather strong interaction effect between religiosity and knowledge on fear ($F (4, 186) = 5.83$, $p<0.001$; $eta^2 = 0.11$) (Fig. 2).

Any fear in relation to science is independent of knowledge for weak and very strong religious believers. Whatever the level of knowledge, they have a certain level of fear and worry about science and scientists. For moderately strong believers, among whom we have the conventional churchgoers, fear is attenuated with higher levels of knowledge. For this category, familiarity with science tends to liberate them from worries. Whether participants

are weakly or strongly religious, fears about science are settled in common sense and more knowledge does not make any difference.

We can conclude that in Nigeria, the knowledge–attitude relation is moderated by religion. The moderately strong religious category, if familiar with science, are less optimistic but also less worried. They thus appear to be more realistic in their relationship to science.

In relation to our RQ4, we find polyphasia in evidence when we consider the relationship between knowledge and evaluative attitudes to science in Nigeria. The two categories, 'strong' and 'very strong' religious are polyphasic because they engage with both science and religion however with different consequences in relation to evaluative attitudes. The very strong are fearful but also more optimistic (science takes on the 'sacred' qualities of shock and awe) while the more conventional believers are more realistic about science, less optimistic and less fearful.

Participant interviews: The place of science and religion in everyday life

Having established that generally, science and religion coexist in Nigerian common sense, we used interviews to further illuminate and validate the cognitive *polyphasia* observed in the responses to the survey questionnaire. How did ordinary members of the public view their experiences with science and religion? Recognising *polyphasia* is one thing, trying to specify the different relationships between two systems of knowledge is a different question. RQ4 seeks to further specify the cognitive *polyphasia* by distinguishing qualitatively different types of relating science and religion.

Those we spoke with are in three social groups: religious workers, science related workers and non-science or religion related workers. Science related include a practising

nurse and a computer engineer; religious workers include church spokesman and an imam who is also a traditional medicine practitioner; and the others include a banker, a soldier and a salesman. Who did they turn to for health and illness?

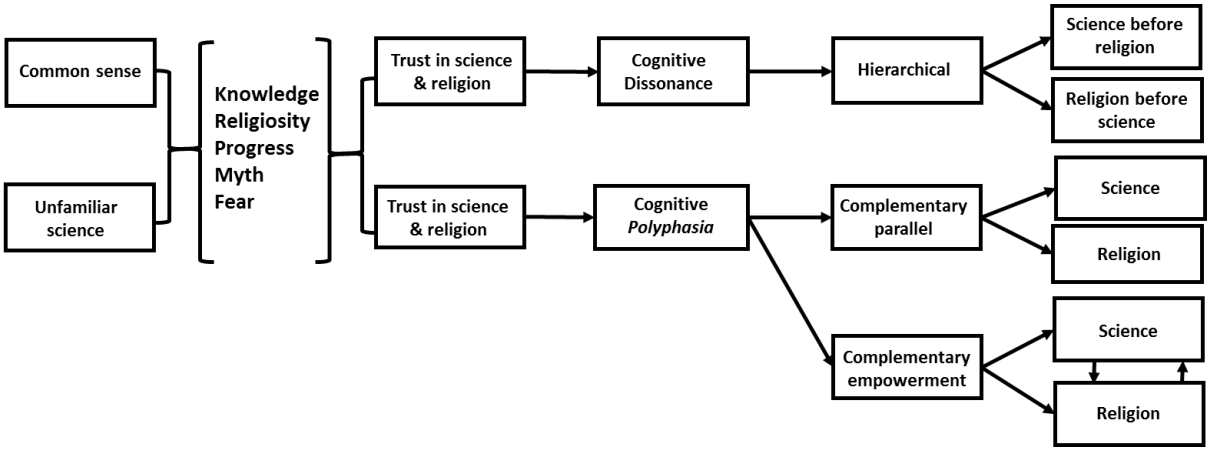

Figure 2. A summary flow diagram showing common sense dealing with the challenge of unfamiliar science.

Like the survey questions, the interviews indicated an uncomplicated side by side relationship of faith in religion and scientific medicine; furthermore, the interviews reveal three different relationships between these forms of knowing. While most participants saw no conflict, some went further to regard the relationship as parallel; others created a hierarchy, elevating either science or God; and again, others saw one empowering the other.

Type 1: Complementary and parallel

Participant 3 agrees with the complementary perspective but did not elevate religion. He argues that even though God protects against diseases, the individual needs to use alternative knowledge as well. Science and religion, for him, are two parallel thoughts explaining different aspects of life, a position taken by Gould (1997) and Midgley (2003). Participant 3's position can also be summarised as heaven helping those who help themselves:

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> '… well if you indulge in unprotected sex and you think God will prevent you from contracting gonorrhoea or HIV, am afraid the answer is no. But to the extent that nowadays in churches they spare time for people to come and lecture them on better lifestyle that way, if you are told not to eat sugar because you are over 40 or to slow down on alcohol or smoking, to that extent, if you obey, you would have helped yourself but it is not a direct God's business preventing malaria or contracting STDs.'

He however believes that God offers protection for unforeseeable events:

> 'maybe you are travelling and you are not sure of what the road will look like, you can pray and… incidences would have happened which if you were on the road you would have been involved, that is possible, I have experienced that before.'

Type 2: Science and technology empower religion

For Participant 9, technology has a positive role as it spreads the gospel, but it can also be negative by disseminating antagonistic messages:

> '... the anti-Islamic thing (video that caused the outburst in the Middle East), if there was no technology, I think they would have acted it on a stage, in a theatre and people would have watched and put it in their heads… but now it was aired, everybody saw it… like on the social media… Technology seems to have spread it that fast. I think that's the negative aspect.'

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Participants 8 and 2 also argue that technology has advanced the propagation of religion rather than reduce it, as it has significantly increased access to religious books and widened audience share through radio, television and the internet.

Type 3: *Complementary but hierarchical*

Science before religion. Elevating science was typified by Participant 8, a computer software engineer who believes that knowledge of science could help God protect him. He was, however, empathic that he 'personally will first deploy science before prayer':

> 'I rate prayer as 40%… for me to protect myself from a particular disease like HIV… Now, I pray that, 'God, do not give me HIV; please, I don't want to contract HIV from anybody'. But I go ahead and have sex with someone that is HIV positive without any protection, I will get the HIV, no matter the prayer I conduct no matter what I do. Without me praying, I keep away from it, I make use of the protection that science has offered, that could be the best possible means of protecting yourself from HIV…'

This may be seen as a contradiction but the participant did not interpret it as such and appears to have adapted to living with it by, interestingly, using probability principles and prayers.

Religion before science. Participants 1 and 2 elevate religion above science. Participant 2 argues that he needs God for science to work: 'even as a Christian, if you are given any medication, your faith in God, that is… if I don't have faith in God, if I take thousands of Panadol (analgesic) then it won't work.' This may also be interpreted as a contradiction, but the participant argues that they do not just coexist – one actually influences the other. Such

disposition, he argues, comes from socialising institutions: 'we are taught from our youth to have faith in whatever we are told about God.' Like Participant 7, he also has faith in both God and science. Participant 1 also believes in the supremacy of religion arguing that 'I believe God will make the Panadol work'.

Participant 11 also elevates God above science, but argues that even though there is conflict in some instances now, there should not be any since 'God is the chairman of everything'. For Participant 10, whatever scientists are practising today, 'God did it before. It was out of God's creation. God inspires them'.

***It depends on faith in science or religion*.** Participant 7 believes in the supremacy of God, but argues that for most people, protection from illness depends on the strength of their faith in either religion or science:

> 'It depends on someone's belief or faith…'
>
> (On religion) 'We've seen instances whereby some people will say no, I can't use drugs, some people will tell you that for the past ten years they have not used drugs…'
>
> (On science) '…you see, some people, even if they are having headache, if they have not been to doctor and… some people, until they get injection, even if it is ordinary water that is in the syringe, once it touches their body they believe that they are well.'

His position best typifies Durkheim's argument that the faith we have in science may not necessarily be different from religious faith.

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Hierarchical as indicating cognitive dissonance. Elevation science or religion above the other is an expression of cognitive dissonance. Participant 2, faced with a choice between science and religion, resolves the dissonance in favour of science. Science, he argues, offers a better protection than religion. Participant 6, a student nurse, agrees there may be contradictions, particularly on evolution:

> 'Science gave us a different evolution and there is also an evolution in the Bible. That evolution is actually going to contradict the one in the Bible, which puts you as a Christian in a psychological dilemma… I believe… I choose… God… the evolution in the Bible. But I think with the facts that science has actually provided, it actually puts me in that state too sometimes, but nonetheless, I still have one mind and I still chose that…'

While she approved the scientific theory of evolution, she identified more with her faith and chose the biblical explanation. The World Values Survey (2015) shows just how widespread her position is in Nigerian culture. When respondents were presented with the statement 'When science and religion conflict, religion is always right', 88% agreed, of which 54% chose the 'strongly agree' option. She sums up her approach to the relationship by saying it is all about knowing your religion and what it preaches:

> 'Should I say God doesn't teach us to be foolish? Even in the Bible it is written that we should be as wise as the serpent… And if you are a Christian that you believe in God… you can't just expect things to happen without you actually doing something. And science teaches us how to do something, how to actually go researching, and in short, finding answers.'

Conclusion

The findings of this study show that in matters of the familiar and unfamiliar, the majority of Nigerians have faith in both science and God or, as one could say – as Cray (2006) does – they want their MRIs and miracles concurrently without seeing any contradictions.

The Nigerian attitudes to science are structured along three latent dimensions: progress and fear, and an element of mythological imagination about science which is independent of knowledge of science and religiosity.

We found some evidence of *polyphasia* in the compatibility of people's interests, being informed and engaged with science and religion. We found clearer evidence of cognitive *polyphasia* in the compatibility of scientific and traditional knowing. Third, we found cognitive *polyphasia* in patterns of trust in different actors. Those who trust the scientist will also trust the religious leader and to some extent other state actors but not politicians.

Most revealing is the evidence of cognitive *polyphasia* in the statistical interaction of scientific knowledge and religion when considering evaluative attitudes to science. The less strong and the very strong religious are polyphasic. They engage with both science and religion, however, with different consequences. The very strong are in shock and awe of science, while the more conventional believers are more realistic, less optimistic and less fearful about science as their knowledge increases. It appears that the scientifically knowledgeable, moderately religious Nigerian follows Aristotle knowingly or unknowingly, who more than 2000 years ago, admonished the virtuous 'middle way' between exuberance and terror as the path to happiness.

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We further specify cognitive *polyphasia* in three different types of relating science and religion in Nigeria: hierarchical, complementary but parallel, and science and technology empower religion and vice versa. We also found that if science contradicts religion (cognitive dissonance), resolving this dissonance with a hierarchy depends on participants; some resolve in favour of science, others in favour of religion. The research findings show the prevalence of cognitive *polyphasia*, and comparative data support a conclusion that different forms of knowing are not limited to pre-modern societies, but remain with us into this millennium. The research supports Durkheim's hypothesis that faith in science may not necessarily be radically different from religious faith, and comparative analysis can support Lévy-Bruhl's hypothesis of co-existence of the old and the new in common sense.

With this study being the first of its kind in Nigeria, we pointed to some basic observations on the complex relations between scientific knowledge, religion and evaluative attitudes to science. The basic facts of religion and science polyphasia in Nigeria might have strong implications for science communication. It is unlikely that the course of science can be advanced in conflict and contradiction with religion among a population 174 Million where 88% agree that religion is always right.

This preliminary evidence leaves us with a heightened need for more research into the relationship between religion and science in Nigeria and elsewhere in Africa. First, we need a nationally representative survey in Nigeria and beyond to examine these questions systematically. Second, we need to develop questionnaire items that are able to distinguish the three types of cognitive polyphasia: hierarchy, parallelity and empowerment. Thirdly, we need to develop analytical techniques to reveal the cognitive *polyphasia* with traditional

indicators of public understanding of science such as evaluative attitudes, knowledge, interest, trust and engagement. Finally, future research might show how cognitive polyphasia is manifest in specific controversies and scientific issues and events in Africa.

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