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THE PRINCESS AND THE PEA: RESEARCH STRATEGIES FOR THE STUDY OF THE MEDIATION OF TIMESCALES BY ARTIFACTS

Kevin K. Birth*

The study of how UTC affects most of its users involves exploring how time services and clocks mediate expert knowledge for non-expert users. This includes addressing how issues that time experts understand can still have consequences felt by non-expert users of UTC, whether these consequences are computer system crashes or the mistiming of important religious practices. This paper develops strategies for studying the assumptions and expectations non-expert clock users have of timescales and explores some of the epistemological and methodological challenges in conducting such studies. Basic interviewing and data analysis techniques are also discussed using examples from the research on religious communities that has been conducted so far.

INTRODUCTION

When I was in graduate school, in a class in which all the graduate students produced papers that were laden with theoretical posturing, my wise professor wrote on our papers: "Your bags are packed. It's time to take a trip."

In anthropology, that means: stop theorizing and start talking to people. Or, to quote the Trinidadian intellectual and cricket journalist C. L. R. James, "Always you must watch what people do not what you think they ought to do."[1]

This is a very important insight. In doing anthropology, we learn that often people do not think or do what we expect. If one goes into ethnographic work looking for data to support a particular position, then one will either be disappointed or produce bad anthropology. In doing research on issues with policy implications, it is important to be what Weisner describes as a "fair witness." He writes, "The committed fair witness is neither foregrounding politicization, nor interrogating the positioning of all involved. Rather this approach is applying the best designs, methods, and conceptual frames possible to provide the strongest research we can offer to understand important problems and improve well-being."[2]

Being a fair witness also means avoiding research strategies that will push those studies to advocating a position in a policy debate. Even though there are two well-defined sides in the discussion about the leap second, one should not expect to find well-defined positions for or against the leap second in doing ethnographic research with those not engaged in the debate. If we watch

* Professor, Department of Anthropology, Queens College, CUNY, Flushing, NY 11367

what people do, and do not try to force them into one position or another, we generally learn that the questions we use to frame our research, including ITU-R study questions, are too feeble and simplistic to capture the diversity of human action or to give due respect to how thoughtful many people are.

This is not to say that ITU-R Study Question 236/7* was bad, only that the course of doing social scientific research changes one's initial questions, and that, maybe before revising TF.460-6, the ITU-R should consider revising Study Question 236/7 based on what has been learned since it was first crafted in 2001.

The challenge in the ethnographic study of leap seconds is the difficulty in ascertaining how those who know nothing of UTC, TAI, BIPM, UT1, IERS, and the ITU-R are currently affected by leap seconds or will be affected if leap seconds are eliminated. For this reason, the discussion about the future of the leap second has centered on domains that are populated with certain kinds of expertise—computer science, systems engineering, astronomy, metrology, geodesy, and related fields. Yet, lurking within the discussions emerges the concern over something called civil time, and civil timekeeping is what this colloquium is about. The study of civil timekeeping involves the study of humans in their natural habitats and an effort to understand how policies about UTC may affect those habitats.

So how does one develop strategies to move from the debate over the definition of UTC to how users with no knowledge of UTC use it? This may seem like a strange question, but all of us depend on knowledge about which we have no knowledge. We surround ourselves with objects that provide us with information based on algorithms of which we are not aware. To understand the representation of a clock or calendar requires a level of learning that a five- or six-year-old can easily achieve; to make a clock or calendar that provides an accurate representation of time from scratch is beyond most people's abilities.

CLOCKS AS COGNITIVE ARTIFACTS

The framework I use to address these issues is one I have explained in detail in *Objects of Time*.[3] This framework emphasizes the interaction of three processes: cognitive mediation, object fetishization, and artifactual determination of cognition. Of these processes, here I shall focus on cognitive mediation and object fetishization.

Cognitive mediation is a term that has emerged in cognitive science and the philosophy of cognition to refer to the use of artifacts or environmental features to address a cognitive challenge.[4, 5] Whether it is taking notes to help remember a discussion or using a calculator to solve a mathematical problem, these are instances of our using something in the world to assist our cognition. The reckoning of time typically involves cognitive mediation. Sometimes, it is using features of the environment, such as cockcrow;[6] the alignment of the position of the sun's setting to a feature on the horizon[7]; or the spawning of sea worms.[8, 9, 10] Sometimes, the reckoning of time uses artifacts, such as sundials that indicate the equinox or solstice based on the length of the shadow[11]; tables for calculating the timing of Easter;[12, 13] or *Circular T* based on the calculation of the ALGOS algorithm on the basis of signals from atomic clocks distributed across the globe.[14, 15]

Object fetishization is a process by which the user of a cognitive artifact need not understand the algorithms on which the artifact's function depends. The idea is derived from Marx's theory of commodity fetishism.[16] In this theory, consumers emphasize the commodity to such an extent

* http://www.itu.int/pub/R-QUE-SG07.236-2001

that they come to be unaware of the production and labor processes involved in making the commodity. When dealing with cognitive artifacts, part of the production and labor process involves the ways in which expert knowledge gets built into the object. The user then becomes ignorant of the expert knowledge or how it was developed.

In the case of clocks, the expert knowledge is considerable. The entry on "horloger" in the *Encyclopedie* compiled by Diderot and his associates distinguishes between a common clockmaker and one who combines clockmaking with artistry. The latter combines "*au genie des machines, donné par la nature, l'étude de la géometrie, du calcul, des méchaniques, la physique, l'art de faire de experiences, quelques teintures d'astronomie, & enfin la main-d'oeuvre*" [a talent for engineering machines, the study of geometry, of arithmetic, of mechanics, physics, the art of doing experiments, a bit of astronomy, and finally, the workforce].[17] Clock users need not have any of this knowledge.

As is often the case with objects that think for us but which we do not understand, when something goes wrong, it is possible to recognize things are not right but be completely helpless to figure out the cause.

COGNITIVE MEDIATION

Hans Christian Anderson's tale of "The Princess and the Pea"[18] is a suitable analogy for this problem. In this story, a pea is clandestinely planted underneath twenty mattresses and twenty eiderdown beds on which a young woman claiming to be a princess was to sleep. In the morning, the woman was asked how she slept, and she said "I have scarcely closed my eyes all night. Heaven only knows what was in the bed." Because she was able to notice the pea through the mattresses and beds, she was deemed a real princess.

What separates most users of clocks from the leap second are multiple layers of time signals, services, and synchronization protocols. As a result, most clock users have no idea that leap seconds exist. Just as with the pea, the assumption is that no normal person would recognize the presence or absence of the leap second through all the mediating layers. The NIST, NTP, cell phone and cable providers—these are all like mattresses.

In dealing with the determination of Jewish *zmanim* (time), the times of Muslim's *salāt* (prayer), and Hindu *lagnas* (astrological alignments at particular moments) we are dealing with several complex cognitive tasks. Since these times are now commonly represented in terms of clock time, one of these cognitive tasks is the representation of clock time. Since these times were defined by pre-clock logics, another task is the determination of these times using traditional methods. In addition, since often the logic that guides clock time is different from the logic that guides the determination of traditional times, there is the cognitive challenge of conversion. Conversion, by itself, can be a daunting task. The book *Calendrical Calculations*[19] indicates how complicated it can be converting between calendars. The task of converting between times of day is even more complicated since it often includes both the calendar conversion problem and the conversion between different ideas of reckoning time. Lastly, there is the question of the artifactual determination of thought. In other words, has the reliance on clock time come to shape knowledge of time and timing so much that traditional time-reckoning is no longer relevant? This is true for many people with regard to the Gregorian calendar. Many Jews, Hindus, and Muslims have only a rough knowledge of the traditional calendars of their religions because holidays are represented in a Gregorian calendar format.

In fact, it is those who have argued that the lay public does not notice or care who put forth the most powerful arguments of how the public notices or cares. The documentation of system crashes are equivalent to the princess knowing that something was underneath her bed. Such argu-

ments make clear that the general public can experience inconveniences caused by leap seconds without even knowing that leap seconds are the cause of the inconvenience. Whether it is flight delays such as when Qantas' system crashed in 2012, or inability to access a Web site, these are consequences people notice. Since these problems were not imagined by very smart people when the leap second policy was implemented in 1972, we cannot assume that today's very smart people are able to anticipate all the consequences of eliminating the leap second or confidently declare that nobody will notice problems in the future. Our thinking is limited by our time and our culture.

The methodological problem in studying the potential effects of eliminating leap seconds is that one cannot ask non-experts in timekeeping about their opinions of leap seconds. This problem is not new in the study of cultural concepts of time. As I have written, one cannot walk up to people and ask "What are your concepts of time" and expect to get meaningful answers.[20] This does not mean that concepts of time are unimportant, but that they are so embedded in other issues or mediated by technologies that they cannot be revealed through direct questioning. The princess knows nothing of the pea, but she can describe how the mattress feels in great detail. So the way to approach how members of the general public will be affected by time policies is not to ask them about the leap second, but about something that they do directly experience, namely, traditional time reckoning ideas, and the uses of clocks. It is possible to learn about the expectations clock users have about clock performance. Based on that knowledge it is possible to infer how decoupling UTC from mean solar time would affect clock use. In the case of religious communities that convert between clock time and religious time, it is possible to also learn the algorithms behind such conversion. With such knowledge, it is possible to then explore how changing the definition of UTC would relate to the expectations users of have of clock time and the processes of converting from one timescale to another.

HYPERCOGNITION AND HYPOCOGNITION

In addition to the strategies that an anthropologist would normally employ in facing such a methodological problem, there is another set of obstacles specific to the leap second debate. Since it is a debate carried on by experts, it has developed its own elaborate vocabulary and culture. All cultures shape how we view the world, and the discussion about leap seconds has created biases that are quite different from the biases of the clock users I have interviewed. In this project, it is not enough to develop strategies to study clock users in the general public, but to also develop strategies to identify the tendencies in the ongoing debate over the leap second. As I shall argue, the biases of both the advocates for and against the leap second are towards technical matters of timescales and away from the general public's use of clock time and its lack of knowledge of what timescales are. As a result, discussions of how leap seconds affect the general public either quickly move toward a technical application of clock time or a dismissal of the general public's ability to care.

A bias is not necessarily something bad. Expert knowledge creates a good bias when dealing with complex problems. But experts talking to experts tend to think in ways that differ from how non-experts think. This can make it difficult for experts to imagine how non-experts think.

As I have worked my way through the literature on the leap second question and the archives of the leap second discussion list,[*] it has struck me how well-rehearsed certain debates are. One of my claims in this paper is that those engaged in the debate have cultural inclinations toward

[*] http://six.pairlist.net/mailman/listinfo/leapsecs

debating certain issues that leads to other topics being neglected. To use a distinction made by the anthropologist Robert Levy, some issues are hypercognized and other issues are hypocognized.[21]

A domain that is hypercognized is one for which there is a sophisticated and nuanced vocabulary. For instance, based on the leap second discussion list and the publications by experts, not journalists, about the leap second, there are several domains that are hypercognized: clocks, Earth, leap seconds, timescales, UTC, and problems.

A domain that is hypocognized is one for which there is limited or no means of discussing it, or in which there is little elaboration and few distinctions. Some notable hypocognized domains are: culture and society.

Finally, a domain that is both hypo- and hypercognized is science. Certain sciences, such as astronomy and computer science, are hypercognized, but other sciences are not. Biological sciences are almost entirely absent from discussions of timescales, even though timescales are of critical importance in disciplines such as chronobiology.

To give a sense of the difference between hypercognition and hypocognition, I'll just briefly compare the diversity of terms applied to timescales with the diversity of terms applied to culture and society within the leapsecond discussion list.

Timescales: ephemeris, GMT, GPS, NTP, TAI, TDT, TT, UT, UT1, UT2, UTC, UTC-SLS, UTS, apparent solar time, astronomical, atomic, broadcast, civil, common, computer, confused, continuous, coordinated, discontinuous, default, definition of, disseminated, dynamical, earth angle, earth-centric, fundamental, geologic, global, globally accepted, hobbled, human, ideal, independent of UTC, internal, international, interrupt-free, interval, leap hour free, leap-secondless, legal, long, low accuracy, mean, monotonically diverging, national, new, non-standard, non-uniform, official, peculiar, physical, POSIX, postal, precision, predictable, pulsar-based, real number, reference, relativistic, rotational, rubbery, segmented, solar, standardized, stationary, statistically formed, stepped, synthetically generated, system, terrestrial, uniform, unsegmented, variable, and widely available.

Cultures: American, lunisolar, technological, timekeeping, Antarctic, and Martian.

Societies: simple, secret, modern, high-tech, civil, spacefaring, technical, functioning, and primitive.

Within anthropology, there is a theory that language reflects thought, and when one finds an elaborate, hypercognized language it represents a great deal of sophistication applied to a topic. Timescales are hypercognized in the debate about leap seconds. Culture and society are hypocognized. There are many types of timescales, but none are explicitly identified as cultural or social.

Now if I contrast the discussion on the leap second list to media representations of the leap second debate and my interviews, I find that the term timescale is hardly ever used, much less elaborated upon. For instance, in the 2006 article in *Harper's Magazine*, the only time that the term "timescale" appears is in quotes from experts[22]—the author of the article does not use the term. More recently, I examined 26 media reports on the January 2012 ITU vote on the draft revision of TF.460-6, and only two used the term "timescale" other than in a quote from an expert. There is a cognitive and cultural gulf between the experts who study and devise time policies and many users of time services.

This is true of social science, as well. Most social scientists do not use the term timescale; they could not define it if they had to; and they would be unable to distinguish a timescale from a non-scalar way of thinking about time. On the other hand, social science has lots of ways of talking about society and culture.

What I hope to offer is a bridge between those who hypercognize the society and culture and those who hypercognize the timescales. In building this bridge, I must warn against what cognitive anthropologists call the "fax model of culture." This is a view of culture that assumes that cultural knowledge is disseminated like faxes with duplicates appearing in the minds of individuals.[23] A good example is the policy change to replace GMT with UTC. Even though GMT is no longer a global timescale, most people still think it is. The policy change did not arrive in the minds of most users of clock time. A policy change made by the ITU and implemented by the BIPM does not mean that civil society will change its thoughts or practices.

Any change in the definition of UTC will filter into this varied landscape of precision and inaccuracy, and hypo- and hyper-cognition. The cultural and social consequences of any redefinition of UTC will not be felt directly by many clock users, but instead will be felt through how this redefinition affects local times and timekeeping practices—in other words, the princess feeling the pea without knowing it was a pea.

THE STUDY OF HUMANS IN THEIR NATURAL HABITAT

As a social science dealing with humans in their natural habitat, the methods and techniques of anthropology are much like any field science. We rely heavily on observation and are wary of statistics. The reason for the latter is that we cannot be sure that what we observe is representative of entire populations. This tends to make anthropologists fall into epistemological frameworks that are either hermeneutic or hypothetico-deductive. I shall briefly explain each epistemological perspective and then discuss the techniques someone in my specialty, psychological anthropology, tends to use.

The hermeneutic method emerged out of Biblical criticism and is associated with the philosophers Schleiermacher[24] and Dilthey.[25] The method involves interpreting the relationship of parts to wholes. In the context of textual criticism, a single verse in the Bible becomes interpreted not only in terms of what it means, but also how that meaning relates to the whole of the Bible. This knowledge of the verse in relationship to the whole of the Bible then refines the knowledge of the Bible brought to bear on other verses. This creates what is dubbed the hermeneutic circle. A criticism is that according to this approach, all knowledge is provisional. To some, this is a strength; human behavior changes so conclusions about it can rarely be more than provisional. Even if one thinks of so-called laws, like the law of supply and demand, the timelessness of the law is an obstacle to its concrete application. As soon as one attempts to understand supply and demand in the behavior of actual people, as opposed to theoretical constructs, one is faced with the hermeneutic problem of defining time period and context.

Anthropology has struggled with epistemology and whether its interpretations are provisional. There have been some attempts to build an epistemology that allows for hypothesis test, such as Spiro's hypothetico-deductive approach which uses hermeneutics to generate testable hypotheses.[26] The problem is that patterns of human action continues to unfold and often change. Recognition of this issue leads some to advocate for a phenomenological approach. Desjarlais and Throop explain, "Our existence as humans is temporally structured in such a way that our past experience is always retained in a present moment that is feeding forward to anticipate future horizons of experience. This includes the dynamic ways that individual actors shift between differing attitudes in the context of their engagements with their social and physical worlds."[27] The phenomenological approach in anthropology is often identified with what is called the "anthropology of experience." In the context of studying timescales, it leads to the study of the moments when timescales are used. This leads to the recognition that in these moments, a clock of some sort mediates between the user and the timescale.

The emphasis on the articulation of the past, present, and future in phenomenological anthropology also emphasizes that the presence of the research can change the attitudes of the people studied. Obtaining research subjects' informed consent in this project raises their consciousness about the future of UTC, since the role of the leap second in UTC must be explained for their consent to be informed.

As a result, the results of any study are specific to a moment, and the history of anthropology is littered with cases of conclusions based on sound evidence at one point in time that are contradicted later. In a way, the ongoing changes to the globally disseminated timescale since 1884 provide evidence of this. What would have been an accurate statement about the determination of time in 1960 would be incorrect today.

In anthropology, statistics are generally not viewed as sufficient for making claims. The reasoning is that statistics have several weaknesses. First, social populations are rarely homogeneous, which raises the issue of how responses should be weighted. Second, in a related issue, sampling in anthropological research is never random, which raises concerns about how representative a sample is. Third, the strategies most useful in gathering a large number of responses, such as surveys, are the most likely to skew data. Surveys always ask questions that reflect what interests the researcher, not the research subjects. In the case of the surveys that have been conducted about UTC, these problems are magnified. The surveys were distributed mostly to people like those issuing the survey. The global population is quite large and diverse and those responding to the surveys represent a small and unusual population. Finally, the questions reflect the interests of those engaged in the debate, not necessarily the interests of the larger population that relies on UTC.

In addition, surveys often consist of leading questions. A leading question is any question that determines its answer. If respondents to a questionnaire are asked whether they agree or disagree with the ITU-R recommendation to eliminate the leap second, there are only two likely responses: either respondents agree or disagree. Often, with regard to complicated issues, many people have complicated perspectives that do not neatly match either agreement or disagreement.

The survey material gathered so far has a use, however. It can be treated as a diagnostic exercise that generates hypotheses to be tested, but it cannot be used to test hypotheses about the impact of the elimination of the leap second in civil society, because the respondents are not representative of civil society globally. To do this involves textual and ethnographic research. Since Hinduism, Judaism, and Islam all involve scriptural traditions, agreement between people's behaviors, their discourse, and scriptural teachings is a powerful source of corroboration. For instance, when Muslims say that in the United States they must rely on software applications to know prayer times, and when those applications have hundreds of thousands of downloads and thousands of reviews, and when the prayer times in the applications agree with the prayer times in the Qur'an and Hadiths[*], then that is a powerful indicator of the extent to which the scriptural tradition is shaping thought and behavior.

Ethnographic research seeks breadth of sources and complementary strategies that allow for the corroboration of information. The key components of ethnographic research are: the strategic selections of research sites, preparation, participant observation, directed interviewing, and non-directed interviewing. If surveys are issued, it is only after the researcher is familiar enough with

[*] The Hadiths are remembrances of sayings and actions of the Prophet.

the values and concerns of the research population to write prompts that reflect those values and concerns.

THE RESEARCH SITE

My selection of a research site does not seem very strategic. It is simply where I live and teach in Queens, New York. Yet, this is an ideal site for investigating the religious uses of UTC. Queens is culturally and religiously diverse, with large Jewish, Muslim, and Hindu populations. Between my own neighborhood and the area around the college, there are over a dozen Hindu mandhirs, about a dozen mosques, and over forty synagogues. In effect, there are many people to consult nearby. Many of the Jews and Muslims have lived in places where public signals indicated religiously significant moments. For instance, in Israel, a siren is sounded before the beginning of the Sabbath. In Islamic nations, one need not know the prayer times because there is a public, audible call to prayer. In Queens, however, these audible timekeeping features of the environment are missing, which forces the faithful to rely on other means to know the timing of their religious obligations. These other means invariably involve some use of clock time. For many, it involves software applications on their computers and smartphones. For others, it involves printed calendars and tables which give clock times for important moments. If there is a context in which a change to UTC would affect religious observance, it would be a place like Queens where so many of the religiously observant are also reliant on clocks to be observant.

ETHNOGRAPHIC RESEARCH PROTOCOLS

Doing proper social scientific research involves preparation. Otherwise, one misunderstands what is observed and asks stupid questions. As the old adage goes, "Ask a stupid question; get a stupid answer." The problem with approaching the issue of the uses of UTC solely from the perspective of time experts and not civil time users is that many of the questions that interest and engage time experts are of no interest or practical utility to non-experts.

To research the requirements of UTC for civil timekeeping, one must know something about the communities to be studied, as well as their timekeeping traditions and needs. In the case of Hindus, Muslims, and Jews in New York, the populations on whom I shall focus, one must be aware of the scriptural and textual traditions which guide their faiths and what these texts say about timekeeping. Admittedly, much of what I have done over the last year since I have undertaken this project is read the Torah, Tanakh, Mishnah, and Talmud as well as the Qur'an and Hadiths and finally, many of the classic Hindu astrological texts. I have also sought out expository discussions and instructional guides on these faiths. Finally, I have tried to learn what it is that lay Jews, Muslims, and Hindus are expected to know and how they obtain their knowledge. Thankfully, in prior projects, I have worked with Muslims and Hindus, and am familiar with many of their religious practices.

Once the preparatory work has provided a sufficient foundation to ask productive questions and understand the answers, one can begin fieldwork. In my case, the initial round of interviews have been largely based at Queens College where I teach. Teaching at Queens College benefits from awareness of religious observances and schedules.

The field research technique anthropologists call "participant observation" involves observing what people do and, when appropriate, participating in what the people are doing. In the case of timescales, it is possible to observe the variety of practices that people use clocks to schedule and the cases where they are converting between different timescales, such as Orthodox Jews who convert between Jewish *zmanim* and UTC on a daily basis. *Zmanim*, literally "time" in Hebrew, refers to the division of daylight into equal segments, which produces seasonally variable tem-

poral hours. For most Jews, knowing the correct times to light the Sabbath candle or recite the Shema, a cornerstone of Jewish prayer, involve converting from *zmanim* into clock times.

In participant observation, unusual events are often the most informative. When rules are broken or people need to improvise solutions, peoples' thought processes are often the most explicitly communicated and seen—"The most ethnographically productive events are those which involve people in public attempts to generate explicit explanations."[28]

When such an event happens, it often leads to a case study. This not only involves documenting the event, but conducting follow-up interviews. Sometimes the events involved in a case study seem rather mundane, such as an Orthodox Jew stopping to pray in the middle of the hallway. In such a case, I can ask the individual how she knew it was time to pray and discuss why she chose the method she did for knowing the time. In such cases, I have learned that the applications that students choose tend to be those that their parents or their close friends use. Sometimes the event is less mundane, such as a catastrophic failure of a key system on which people rely, or somebody grossly violating an accepted norm.

I use directed interviewing techniques to learn ritual requirements in different religions or the tools that are used. Indeed, my most common directed interview is quite short. It is: "What app do you use to know prayer times?" In Hinduism, Judaism, and Islam, time and timing is of great importance. The teachings on this are fairly clear in each religion, but the application of these teachings in daily life get complicated. For instance, in the case of Islam, the prayer times and the beginning of each month are clearly defined in the Qur'an and the Hadith, but they are defined in relationship to Mecca. For instance, the month begins with the appearance of the crescent moon, but as one Muslim said, "Which moon?" All the Muslims with whom I have talked, even informally, have mentioned the controversy over whether the sighting of the moon should be local or whether a sighting anywhere in the world suffices. One consequence of this controversy is that many Muslims in Queens complain that they and their friends celebrate Eid al-Fitr, the feast that ends the month of Ramadan, on different days. It all depends on what sighting of the moon they and their congregation use, and since different congregations use different sightings, they begin and end Ramadan on different days. As Ilyas notes, this is an international problem,[29] but since Queens is a place where Muslims from many nations meet, it is particularly felt there.

In the case of Judaism, the difficulty of relating local times in Israel to the diaspora have led to different sets of laws applying to the duration of holidays in diasporic populations—the second day, or *Yom Tov* of many holidays. During the period of the Temple, the beginning of the month was determined by the Sanhedrin acknowledging the observation of what is called the new moon. In fact, the new moon in Judaism is the first sliver of the moon's reappearance. A message would then be sent to populations outside of Jerusalem. Since Jewish holidays are tied to specific days of the lunar month, to know the day of a holiday required knowing when the month began, and one could only know when the month began based on the announcement of the Sanhedrin. To deal with the delay cause by travel time, many diasporic communities were unclear as to when the new month actually began. This problem was addressed by requiring the that holidays be celebrated on two consecutive days—the *Yom Tov*.[30] The tradition of the *Yom Tov* continues and covers all Jews who do not live in Israel even if they are visiting Israel. This can create a problem, particularly with Passover. During Passover, no food with leavening is permitted in a Jewish household. Rather than waste food, a rabbi makes arrangements to sell the food to Gentiles for the duration of Passover. The food is then bought back once Passover is finished. As one person told me "I remember when I was in Israel, the last day of Passover was Saturday. Now in Israel they only observe one day for Passover, but in the US we observe two. In Israel the Rabbi buys back the unleavened stuff one day before it is bought back in the US, but if you are from the US but in

Israel, that can really mess you up." He went on to explain that an American Jew in Israel must be careful that the Rabbi in charge of buying back leavened items is aware he is doing so for Americans.

Knowing the formal requirements for any group is not sufficient for knowing what people actually do. In studying what people actually do, I combined participant observation with non-directed interviews. When a handful of people freely and independently state the same opinion, that is actually much more significant than if many people respond the same way to leading questions. In non-directed interviews technique, I use a limited set of prompts and form most of my questions based on what the person I am interviewing says. The technique is meant to avoid leading questions and to ascertain the values and opinions of the person interviewed. If in the natural course of the conversation the person interviewed covers the other prompts, I do not ask them. The result is that the data is not suitable for statistical analyses, but is still able to be coded and compared.

A general rule of thumb in non-directed interviewing technique is that the more the interviewer talks, the less the interviewer learns, so an interviewer develops skills to steer an interview without saying much. For instance, in this interview with a Muslim:

M: The moon is not seen all over the world. People might miscalculate. Some people say that the moon's phases can be calculated; some say no—that you have to see the moon.

KB: uh huh [nods head in affirmative]

M: If a scientist calculates when the moon will be sighted, some say it works, but others say "no." They say the Prophet didn't calculate.

KB: mm hmm

M: The Qur'an says that motion is subject to calculation. Motion can be measured. We call it *Hizab*—calculation. Motion is according to calculation and mathematics can calculate. This is what the Qur'an says…

KB:[I nod emphatically and try to look particularly attentive while he reaches for his copy of the Qur'an.]

All of these techniques are most effective after one establishes rapport. Rapport is a degree of comfort between those studied and the anthropologist. The more comfortable with the relationship the research subjects are, the more likely they are to be willing to be interviewed, and the more likely the interviews will produce useful information. I admit that establishing rapport is a significant obstacle in this particular research project since, when classes are in session, I do not have the time to be in frequent contact with potential research subjects to cultivate their interest in helping me with the project. In my experience, when living among a population, rapport takes four to six months to establish. Doing work by means of establishing contact by telephone or e-mail is, in my experience, prolonging the time it takes to establish rapport. As a result, I would view my results as preliminary.

DISCOURSE ANALYSIS

The interview material needs to be transcribed, coded, and indexed to be of any use. Once that is done, the discourse analysis can be performed. There are several sorts of strategies for seeking information. One is simply to note what people say—this is a content-based approach. In analyzing the discourse, one can also pay attention to metaphors, shifters, and code switching. Metaphors are cognitively interesting since they link quite different conceptual domains.[31, 32] Shifters are commonly, but not always, pronouns. Because their meanings are dependent on their anteced-

ents, their meaning can shift, and how speakers choose to use these shifters can indicate a great deal about their thinking.[33] Attending to how people transition naturally from one topic to the next is also useful. Usually, this indicates a cognitive connection between the two topics. I shall give an example from an interview with a Muslim in both a content based and a transition based approach.

This comes from an interview with Dr. Ali Mermer, the chaplain of the Islamic Student Association of Queens College. The context of the discussion was how Muslims know when Ramadan will begin. My research subject said: "This is what the Qur'an says in chapter 5, verse 5: 'The sun and the moon run on fixed courses, exactly calculated.' Therefore, the [crescent] moon can be calculated. For example, Saudis claim that they are the authority. They calculate and go up in an airplane to sight the moon. But some experts can prove them incorrect. … So the dispute goes on. Saudis say 'we calculate correctly.' Egyptians say, 'We have scholars who know when the moon will be seen.' Turkey says, 'We are the most developed and have authority.' "

A content-based analysis shows that calculation is possible and that different nations make claims for offering the most authoritative calculations. Yet, there is more information embedded in this statement than the surface content. Note that the speaker moves from the Qur'an to the Saudis to the Egyptians to the Turks, and that this parallels a movement from correct to calculating correctly, to knowledge of calculation, to development.

The speaker then transitions with no urging from me to an evaluation of this situation: "There are no universally accepted criteria. So some say that the Prophet did not follow calculations and therefore we should not follow calculations to uphold the prophetic tradition. Our practices have their base in worship, and calculation does not match the spirit of worship. Worship means responding to God."

This points to another set of transitions which involve shifters. The quote starts with the Qur'an but then uses shifters like "they" and "some" to refer to calculations and experts. He then transitions to use "we" and "our" to those who base their practices in worship and do not use calculations.

At this point, because of the transition, I am aware of a contrast between calculation and worship, and the leanings of Dr. Mermer against relying on calculations. This is important information since the interviewer must always be conscious of why a person is saying what they are saying.

Dr. Mermer then continued: "Worship means responding to God. It is thanking him. It is like thanking a host. When you visit someone you do not thank them if they offer you nothing. If your host gives you food, you respond by giving thanks to the host. You express feelings as a response."

This statement is full of meaning that goes back to when I first entered Dr. Mermer's office and he offered me a cookie. The insight into the relationship to God is framed by a very human example. The conversation takes another turn, away from evoking the memory of the cookie and hosts giving food back to where the conversation began—fasting during Ramadan: "So, what is the point in fasting? It is appreciation of the month of fasting given by the Creator. We are blessed with the month of Ramadan. It is a response to Your lordship. We obey the order and respond to Your gift as Creator. It is the physical relations between the actions of God and the human response. The basis for it is the feeling behind worship; it is the acknowledgment of the actions of the Creator."

So let me recap the transitions so far: Ramadan to calculation, to nationalist politics and competition to calculation is not worship, to feelings about a host who offers food, to fasting as a gift

and the physical dimension of worship. Through his actions and the subtle biases in his speech, Dr. Mermer indicated his preference for the experience of worship over calculation. Taking into account that he began by summarizing claims about calculations made by Saudi Arabia, Egypt, and Turkey, it seems that there is also an anti-nationalist sentiment in his reasoning, as well.

The discussion then concludes with a contrast: "One school of thought is that to experience the action of God one must see it with the eye of the mind and heart. To do this, one can calculate without having to see the action with one's own eye. Another school of thought is that we are given the ability to see and experience creation, and when we see and experience it, it makes us feel present in the actions of God."

Whereas the first interpretation based on content indicated that Dr. Mermer was emphasizing the issue of calculation, now there seems embedded in his discourse an emphasis on embodied worship—a relationship between body and mind focused on the Creator in thought and movement. This embodied spirituality is contrasted with calculation in his discussion. Moreover, the shifters are important indicators of how he thinks about the world. "We" engage in this embodied worship in contrast with the position that "some say" and various "schools of thought" including Saudi Arabia, Egypt, and Turkey. This reveals a concern about allowing others to mediate between oneself and God. The emphasis on the physical experience is also indicated by the metaphorical field that Dr. Mermer uses. He emphasizes feelings—a tactile way of talking about emotions.

Yet, Dr. Mermer's words and the texts are not the only relevant information. Dr. Mermer has printed tables with prayer times and an application on his smartphone that sounds an alarm when a prayer period begins. Indeed, this alarm sounded during the interview. The hermeneutic approach dictates that this information is part of the context of interpretation, so it is not enough to conclude that Dr. Mermer does not like calculations, but one must understand his relationship to tools that emphasize calculations. Later in the interview I could follow up on this, and he explained that he knows the traditional timekeeping methods so that he can determine the prayer times by the position of the sun. He then added that many times he is not in position to see the sun, so he must rely on his smartphone or a printed table, but that his preference is to determine the prayer times on his own. In this way, he is like other Muslims with whom I have talked who have ambivalent feelings about the use of electronic devices to know prayer times.

The transitions, metaphors, shifters, and contrasts tell me a great deal about this Dr. Mermer's preferences and thoughts. But I am faced with two problems. First, is this reliable evidence? Second, how to I represent this ethnographically? The first problem is easily solved by two means. First is to be aware of the authority of the person speaking. In this case, Dr. Mermer is a man to whom my Muslim students look for guidance and insight about Islam—he is respected by others and his opinion carries weight. Second is the principle of corroboration which involves seeking other sources of information that independently affirm what Dr. Mermer said. These sources could be other people or texts with authority. I am not comfortable with the small number of Muslims with whom I have talked. With regard to texts, however, there is a wealth of books about worship in Islam and these books refer back to the Qur'an and the Hadiths. The Qur'an and the Hadiths emphasize physical actions of worship.

CONCLUSION

What these methods reveal is that the importance given to timescales among those debating UTC is absent from those with whom I have talked. They do not use the term timescale and are more concerned with knowing the right time for a religious action than whether or not that time is determined by a timescale. Yet, knowing the right time is often dependent on devices that repre-

sent time in terms of UTC. It is this mediating relationship of time-telling tools that constitutes the domain where any changes to UTC could become like the pea making the mattress uncomfortable.

This means that religious timekeeping does not rely on a single way of knowing time that is a timescale, but there is evidence that it does rely on UTC to represent times derived from traditional ways of reckoning time. To understand the requirements of civil timekeeping for religious purposes, then, requires understanding multiple ways of knowing time and how these ways articulate, not just the use of UTC for religious purposes.

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