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Why are there so many Engineers among Islamic Radicals?

Abstract

This article demonstrates that among violent Islamists engineers with a degree, individuals with an engineering education are three to four times more frequent than we would expect given the share of engineers among university students in Islamic countries. We then test a number of hypotheses to account for this phenomenon. We argue that a combination of two factors – engineers' relative deprivation in the Islamic world and mindset – is the most plausible explanation.

Keywords: Jihad; Islamism; Engineers; Political violence; Education; Relative deprivation.

Introduction[1]

SINCE THE EARLY 1980s, numerous authors have mentioned in passing the link between science and engineering and radical Islam.[2]

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Some have speculated about what possible explanations.[3] No one, however, has attempted to find a systematic confirmation of the phenomenon, let alone an empirically grounded explanation. Scholars have found evidence of a positive correlation between *level* of education and militancy both among Islamic and left-wing radicals.[4] Almost nothing is known, however, about the link between different *types* of education and radicalization generally. Yet, there are good grounds, and some evidence that we discuss below, to expect that certain political and ideological orientations could be either promoted or selected by the discipline one chooses to study.

Much of the literature on extremism claims that there is no clear ''terrorist profile'': radical Islamists have few individual traits in common (Nesser 2004; Sageman 2004; on profiling failures *cf.* Capoccia, forthcoming). It nevertheless appears improbable that anyone can become radicalized if only the circumstances are right. Individual choices based on cognitive and personality traits are likely to play a role at least at the point when broader ideological networks get pared down and radicalized. Such traits tend to be very difficult to observe when it comes to militants, certainly on a statistically relevant scale. The choice of education is one of the few micro-level features on which we have reasonably reliable data, which could betray underlying individual traits.

This is the rationale of the present article. Its first part will examine a wide range of evidence to establish the size of the engineers' presence among Islamic radicals, both in the Muslim and in the Western world; in addition, we consider their presence in two control groups, non-violent Islamic groups as well as non-Islamic extremist groups. In the second part, we try to make sense of the pattern of findings, testing both environmental and individual-level explanations for the distribution of degrees among Islamist radicals.

1. *Islamic extremists in Muslin countries*

To test whether engineers are really over-represented, we compiled a list of 404 members of violent Islamist groups in the Muslim world drawing on a variety of sources (Table 1). In the sample there are

[3] Abuza 2006; Bergen and Pandey 2006; Sageman 2004, p. 76; Schulze 1990, n. 22; Waltz 1986.

[4] Russell and Miller 1977; Krueger and Maleckova 2003; Krueger 2007; Berrebi 2003; Ricolfi 2005.

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TABLE I
Sample sources

Description	Source	N
International jihadis involved in 1993 World Trade Center attack, 1998 bombing of US embassies in Africa, 2002 Bali bombings, and September 11	Provided by Peter Bergen and Swati Pandey, complemented by library and internet research	75
International salafi jihadis	Sageman (2004), combined with library and internet research	126
Hamas (Palestine)	Hamas websites, Rangwala (2005); Smith *et al.* (2003)	81
Takfir Al-Hijra and Military Academy Group (Egypt)	Ibrahim (1980, 1982)	34
Jamaa Islamiya (South East Asia)	Singaporean government documentation	31
Islamic Jihad (Palestine)	Websites and literature	18
Sundry cases (further Afghani, Pakistani, Egyptian and Iraqi groups)	Websites and literature; daily press surveys; Smith *et al.* (2003)	39
Total		404

individuals from 30 nationalities, 9 larger groups and no less than one dozen smaller groups. This set does not fully represent what is a varied universe of unknown size, but is large and disparate enough to allow us to establish whether the puzzle holds true.
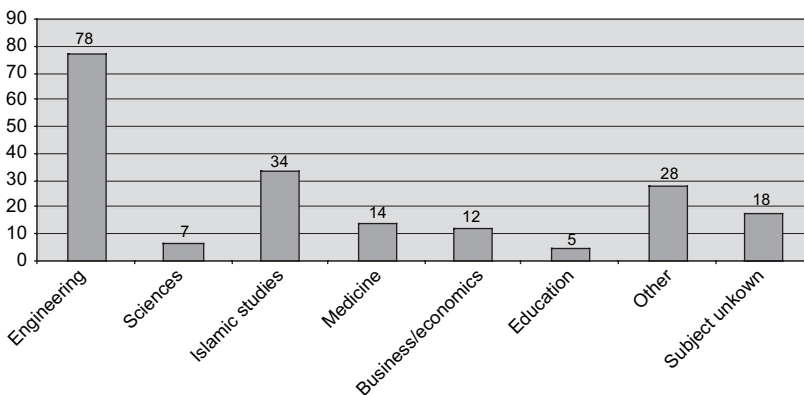
Education levels

We searched wherever we could for information on each of the 404 individuals in our sample, and found some biographical information

for 326 cases and educational information for 284. Out of these, 196 had higher education, whether finished or unfinished, and at least 37 studied in Western countries; the median date of birth is 1968. The share of individuals with higher education appears impressive: 69.0 %. This is much higher than the tertiary enrolment rates in the various countries of origin (12.2 % in the Arab world in the 1980s; Longuenesse 1990, p. 329). Only in the South East Asian groups was the level of education lower than in the rest of the sample.

Education types

We were able to find the subject of study for 178 of the 196 cases engaged in higher education at some point (Figure 1). Unsurprisingly, we found that the second most numerous group was composed of 34 individuals who pursued Islamic studies. Yet, the group that comes first by far are indeed the engineers: 78 out of 178 individuals had studied this subject. This means that 44 % of those whose type of degree we know were engineers. On the whole, the individuals who studied for what we may call "elite degrees" – engineering, medicine, and science, generally the most selective programs in the Islamic world – represent 56.7 %.

F I G . I
Higher education in our sample (196 cases)

Our sample could be biased. For instance, lower-level operatives in certain groups are less likely to be reported, and these might have generally lower levels of education. Yet, there is no reason to expect a systematic reporting bias regarding the *type* of education.

A further finding gives us confidence in the robustness of our result: the predominance of engineers is not clustered in any one of the sample groups, but spread evenly across them. The same obtains if we re-arrange the data by the subjects' nationality – with the exception of Saudi Arabians which we discuss below.

How over-represented are they?

We estimate that the average share of engineers among the total male working population in the countries of our sample, weighted by the number of cases per country, is about 3.5 %.[5] If we leave out Singapore, a country with an extraordinarily high number of engineers, the share is 2.1 %. By contrast, even if we include all missing values in the denominator, engineers are still about 19 % of our total sample (78/404), nine times greater than a null hypothesis would predict.

But how do engineers compare to other graduates? To address this question we must compare our results with (male) enrolment rates in different subjects. We found this data for twelve countries covering 169 of the 196 relevant cases with higher education. The over-representation of engineers in our sample is present for all these nationalities except Saudi Arabia (see below). The average share of engineers among total male students weighted by the number of cases with higher education per nationality in our sample is 18.0 %, while the ratio of engineers over those with known higher education in our sample is 43.8 %. The odds of being an engineer in our sample are three and a half times greater (significant at $p < .001$).

The Saudi exception

When looking at the nationality of the individuals in our sample, one peculiarity worth noting emerges: scattered across several of our groups there is a contingent of 25 Saudis, 11 of whom have higher education, with the subject known for 9 cases. Only one of them is an engineer. This gains significance when we consider another sample of

[5] This is based on labor market data from LONGUENESSE (1990, p. 328) as well as UNESCO education data (2005).

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Saudi Islamic insurgents collected by Thomas Hegghammer (2006). Out of a ''core'' of 70 violent Islamists active in the recent domestic insurgency in Saudi Arabia, he found educational data on 36, 17 of whom had college exposure. Among the 11 of these for whom the subject is known, five pursued religious degrees but again only one was an engineer. Combining the data, we find only 2 engineers among 20 cases with known higher education. Finally, among the 25 individuals involved in 9/11, there were 15 Saudis and 8 engineers. A full seven of the ten non-Saudis were engineers, but only one Saudi was. What are we to make of this exception? We will return to this later.

2. *Islamic extremists in Western countries*

Before attempting to explain what's ''wrong'' with engineers, we must consider whether they are also overrepresented among a different group of violent Islamic extremists, namely those born in or residents of Western countries who became active in recent times, mostly after 9/11. For this purpose we assembled 265 names of Islamic extremists who are citizens or residents of a Western country, and have come to the attention of Western authorities for carrying out or plotting a terrorist attack in the West.[6] Altogether 36 plots are covered.

The sample is close to the universe of violent Islamic extremists caught in the West up until the end of 2006. Out of 265 individuals, 259 are residents (many of them citizens) of 13 Western countries.

We searched for biographical information on the names in our list in a variety of public sources. Despite the fact that most of these individuals were caught, tried or died in the West under intense media scrutiny, we found information on the education of only 54 cases and information on the occupation of 38 additional cases.

Among the 54 for whom we found educational information, 21 had secondary education, while 33 had either some university exposure (20) or a university degree (13). We found information on the type of degree pursued by 22 out of those 33 (Table II): nearly all are from the above-mentioned ''elite degrees'' and engineers alone represent 59.1 %. Even if the overall number of graduates we identified was lower than the real number of graduates in the sample, there is no reason to

[6] The bulk of individuals, 229, come from Bakker who has assembled a comprehensive list of European jihadists (BAKKER 2006, p. 59 *sq*.).

TABLE II
Type of university degree, complete or incomplete

Type of degree	N	%
Engineering	13	59.1
Natural sciences	4	18.2
Economics, business, accountancy	3	13.6
Sports science	1	4.5
Social work	1	4.5
Total known	22	100
Unknown	11	–
Total	33	–

believe that the distribution by degree should be significantly biased. In addition, the 33 individuals with known university exposure are spread over 14 of the 36 acts or plots in the sample.

While the engineering overrepresentation survives in the Western sample and appears even stronger, the proportion of graduates is lower: in the sample of 404 non-Western jihadists, the share of those with higher education even if we include missing cases is no less than 48.5 %, while in the Western sample the corresponding proportion is 12.5 % (33/265), despite much higher tertiary enrolment rates in Western countries. As the missing cases in the Western sample are spread evenly across groups, we suspect that non-reporting of higher education indicates absence thereof – for why should it be reported for some individuals in the same group, but not others? The criminal background of around 20 % of cases and the fact that the 38 individuals on which we found occupational data all held non-professional jobs, also lead us to conclude that levels of education are much lower.

In conclusion, the evidence suggests that compared to the cases in our Muslim world sample, the Western based jihadists have attracted far fewer graduates and fewer qualified individuals and many more from a lower class and lower middle class background. Yet, despite this apparent ''lumpen'' status of Islamic extremists in the West, we find among them proportionally even more engineers than in the first sample.

3. *Non-violent Islamists*

The individuals in the samples considered so far include only members of violent groups, but what about *non-violent* Islamic movements? One thing we know for certain is that Islamic parties and movements usually contain a fair share of highly educated individuals.[7] With respect to the distribution of subjects there are both similarities and differences relative to the sample of violent Islamic groups in the Muslim world.

We managed to collect data on a variety of non-violent groups in eight of the Islamic countries in our sample (see Table III). They show a striking difference from our samples of violent groups: in non-violent Islamic activism engineers, although strongly present, appear to be far less dominant. They are joined by a strong, often stronger contingent of other elite degrees (OEDs) such as medicine, pharmacology and science.

If we consider that OEDs constitute only around 10 % of the total male student body in the Egyptian and Jordanian cases, i.e. equal or less than engineers, OEDs appear to be clearly overrepresented among non-violent groups, and at least as strongly represented as engineers. By contrast, in our main sample there are only 23 OED cases and 78 engineers. While Islamist radicalization seems to appeal to both engineers and other elite students, engineers seem more prone to end up in violent groups (Table IV).

4. *Non-Islamic extremists*

Could this mean that engineers are more prone to militant extremism in general? To test for this we carried out a survey of literature and several primary sources on an assortment of violent groups outside of the Islamic world (see Table V). Although far from exhaustive, the gathered information covers a large set that reveals clear patterns. First, we failed to find engineers among left-wing extremists active after World War II, despite their generally high levels of education: left-wingers of the RAF, the Japanese Red Army, the Italian Red Brigades, and Latin American urban guerrilla groups included almost no engineers, but were rather dominated by law and humanities

[7] BEST 1999; HOFFMAN 1995; LOBMEYER 1995; MOORE 1994; MUNSON 1986; WICKHAM 2002.

TABLE III
Degree distribution in non-violent Islamist groups

Country	Groups	Engineers	Other elite subjects*	Total
Egypt	Muslim Brotherhood MPs	18	12	88
Kuwait	Islamist MPs	1	2	18
Jordan	Islamic Action Front founders	22	42	353
Syria	Hizb ut-Tahrir prisoners	10	17	59
Saudi Arabia	Islamist dissidents	0	3	5
Morocco	PJD MPs	3	9	42
Indonesia	Various parties	5	2	16
Malaysia	PAS, ABIM	0	1	4
Total		59	88	585

Sources: Azam 1997, Middle East newspapers, party, movement and parliamentary websites, personal communication with Stephane Lacroix and Joshua Stacher.
*This includes medicine, pharmacology and basic sciences.

students. Anarchists with 6 engineers among cases with a known degree (compared to 20 lawyers) are only a partial exception.

By contrast, among right-wing extremists, who generally had much lower levels of education, engineers if not over-represented are at least clearly present. Among 287 right-wing extremists and neo-Nazis in Germany and Austria involved in 33 groups, we found 29 individuals with known higher education 6 of whom were engineers. In the US extreme right, whose ideology often has a strong religious and millenarian underpinning (Handler 1990) and whose members are generally poorly educated, engineers have played a significant role as

TABLE IV
Percentages of engineers and OEDs in violent and non-violent groups

	% Engineers	% OEDs	Total (N)
Non-violent	40.1	59.9	100 (147)
Violent	77.2	22.8	100 (101)

TABLE V
Graduates and engineers in non-Islamic radical groups

Anarchists	Our search in the biographies of 700 international anarchists – covering 19th and 20th century individuals and most European countries, the US, Russia and several Asian countries – yielded 54 cases with a known degree, 6 of whom were engineers, 10 doctors, 20 lawyers, and 15 philosophers*.
Post WWII Left-wing extremists	Most 1970s *German left-wing terrorists* studied humanities (Jäger *et al.* 1981; von Baeyer-Katte *et al.* 1983). No engineer among 17 members of the *Rote Armee Fraktion* cases with known higher education (www.rafinfo.de). In a sample of 67 members of the Italian *Red Brigades* and other radical leftist Italian groups, which is part of a database under construction by Valeria Pizzini-Gambetta, out of 34 known education achievements, 16 had either a university degree (6) or some university exposure (10); of those, 10 were in the arts, humanities or social sciences, 3 in natural sciences, 1 in maths, 1 in physics and 1 in engineering. Most radical *US leftists* were doctors, lawyers or had a liberal arts education (Smith and Morgan 1994). *Latin American left-wing radicals* in the late 1960s were mostly graduates of law, humanities, and medicine (Russell and Hildner 1971). Members of the *Japanese Red Army* were mostly university students or graduates and mostly from liberal arts fields, with only very few medical doctors or students and one physicist (Patricia Steinhoff, personal communication).

Table v (Continued)

	No significant example of engineers found anywhere outside of the Islamic world (Russell and Hildner 1971; Smith and Morgan 1994; Jäger *et al.* 1981; von Bayer-Katte *et al.* 1983; authors' survey of numerous websites).
Post WWII Right-wing extremists	A survey of three *German right-wing parties* yields a presence of some engineers, but no over-representation compared to the share of engineers among German graduates (federal and state-level websites of Nationaldemokratische Partei Deutschlands, Republikaner and Deutsche Volksunion). Among 287 *right-wing extremists and neo-Nazis* in Germany and Austria, we found 29 individuals with known higher education, involved in 33 groups, 6 of whom were engineers. Among seven educated *leaders of US extreme right-wing* groups whose degree or occupation we could establish, three were educated as engineers and another one worked in the electronics industry (Smith and Morgan 1994; web surveys).

*Survey of biographies on <http://ytak.club.fr/index.html>.

leaders of several groups: out of seven individuals for whom we were able to establish the degree, four were engineers. With generally fewer graduates around, however, right-wing engineers do not stand out as strikingly as *Islamic* radical engineers.

As a final step to delimit the phenomenon, we need to ask a narrower question to control not for ideology but for country conditions: do engineers have a propensity to become radicalized not in general but in *Islamic* countries in particular? There is some evidence that local context could explain their radicalization.

In their survey of 350 individuals members of eighteen groups of urban left-wing revolutionaries in ten countries around the world Russell and Miller (1977) found that engineers were never a significant

presence with two striking exceptions: Iranian and Turkish groups had a high proportion of engineers, and Iran and Turkey were the *only* Islamic countries in their survey.[8] At a time when left-wing groups were considered, by revolutionarily inclined youth worldwide, as the best means to change the world, radical engineers seem to have been prominent in them in the Islamic world too.

Our own search in the biographies of 205 non-Islamist Palestinian militants seems to corroborate this finding.[9] At least 101 of the 205 had higher education; among the 93 cases in which the subject is reported, we found 16 doctors, 14 trained in economics or business-related subjects, 10 lawyers and 10 engineers. So, unlike in left-wing groups outside of the Islamic world, engineers are present among *non-Islamic* Palestinian groups, though they are not over-represented (*cf.* also Russell and Miller 1977, p. 28).

5. *Summary of findings*

The puzzle from which we started appears confirmed: the number of militant engineers relative to the total population of engineers is miniscule – yet engineers, relative to other graduates, are overrepresented among violent Islamic radicals by three to four times the size we would expect.

While the overrepresentation of university-educated individuals among Islamic extremists varies by country, group and sample, the engineering overrepresentation seems insensitive to all three variations – with the one exception of Saudi Arabia (Table VI).

Among non-Islamic extremists, we find virtually no engineers in the violent left-wing – in Europe, US, Japan and Latin America – even in those groups in which highly educated individuals are predominant. Only in some Middle Eastern countries has there been a significant presence of engineers among left-wing radicals. On the extreme right of the political spectrum, by contrast, while not overrepresented, engineers are present in groups of various kinds all over the world.

In the rest of this paper, we shall not try to explain why certain engineers rather than others became radicalized. Our goal is more

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[8] For further references on engineers in radical Iranian leftist movements *cf.* CHEHABI 1990, p. 89; ABRAHAMIAN 1989, pp. 229 *sq.*

[9] Taken from Glen Rangwala's compilation of biographies; http://middleeastreference. org.uk/palbiograph.html (accessed October 2006).

TABLE VI
Overrepresentation of university-educated individuals, engineers and
OEDs in radical Islamic groups

Country	Type of group	University educ.	Engineers	OEDs
Middle East	Violent Islamists	Yes	Yes	No
	Non-violent Islamists	Yes	Yes	Yes
S. Arabia	Violent Islamists	Yes	No	None
South East Asia		No	Yes	No
Western		No	Yes	No

modest: we will try to explain only why engineers became *more* radicalized than individuals with other degrees.

We will first argue that two plausible hypotheses – network-based expansion of groups and the selection of engineers because of their technical skills – do not survive close scrutiny. Next we will present evidence supporting two other hypotheses – engineers' peculiar cognitive traits and dispositions, and the special social difficulties faced by engineers in Islamic countries. Our argument is that the pattern of results can be best explained by the interaction between these two forces.

6. *Hypotheses: network diffusion*

Illegal groups are set up in a clandestine fashion and their existence is advertised along networks of pre-existing social bonds. If the prime movers were, even accidentally, engineering students or graduates, their network would be more likely to expand within the faculty in which they work and socialize, among like-minded people with whom they interact on a daily basis (for a strong statement of network explanations *cf.* Sageman 2004). A combination of historical accident and network-based diffusion could explain the engineers' over-representation.

However, the more we find engineers to be over-represented in different countries and different networks the less likely it is that their presence is due to a historical contingency. Even in the most restrictive interpretation, our main sample of jihadists contains four clusters – North Africans, South East Asians, Palestinians and international Arab

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jihadists – which grew independently of each other, and engineers are strongly present in all of them. We also find that engineers are over-represented among the Western based extremists, scattered over several unconnected groups.

Moreover, in broad-based movements such as Hamas, network effects should become less important with the growing scale of mobilization. None of this implies that the *size* of the engineering contingent within each independent cluster is unaffected by network effects – it very probably is. What we cannot explain by network effects are both the disproportionate share of engineers who became prime movers and their greater willingness to stay in or join a radical network even if started by non-engineers.

7. *Selection based on technical skills*

What about the most obvious hypothesis: recruitment based on technical skills? Technical knowledge can help in creating and handling the tools of violence as well as in maintaining clandestine communications.

Deliberate recruitment for technical tasks probably occurs with respect to the *internal* allocation of tasks for specific operations – three of the four 9/11 pilots for example were engineers. However, several facts suggest that this explanation does not really work for recruitment in general.

First, we have found no evidence at all of recruits being selected by technical skills. Personal trust seems a more important criterion in the formation of, for example, al-Qaeda cells (Sageman 2004, p. 92). Bomb-making is usually performed by a few specialists, which would leave the high share of engineers among many organizations unexplained. That engineers are mainly sought for their ability to fill technical roles is also refuted by the case of Hamas where many engineers serve in senior management positions with no technical function (while many Hamas suicide bombers pursued religious degrees, Pedahzur 2005).

Next, the technology involved in most violent attacks has been relatively simple and did not require great expertise. It is much more difficult to obtain good quality explosives than to put them to use. Lastly, it is doubtful that violent movements with a larger share of engineers have mustered a greater destructive power than groups

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without. Consider, for instance, the Saudi insurgency, which mounted devastating bomb attacks in 2003 and 2004; or the LTTE in Sri Lanka, the IRA and ETA separatist movements, whose members have come largely from among the poorly educated and the working class.

8. *The engineering "mindset"*

The cross-cutting presence of engineers in militant groups, seemingly indifferent to time, social and country variations, is arguably a sign that individual-level traits must be part of the explanation. Having discarded the technical skills hypothesis, it is difficult to imagine these traits as not being related to personality or mindset.

Regardless of which personality traits exactly are at work – something to which we shall return later – if the "mindset" hypothesis obtains, a twofold prediction follows: first, we should find engineers to have a *greater predilection towards joining radical political groups* regardless of Islam. Our findings concerning non-Islamic extremists show that, to some extent, this is the case, but with respect to right-wing groups only. If their mindset explains this divide between right-wing and Islamist groups on the one hand, and left-wing groups on the other, this would imply that it sustains the pursuit of radical change only if this is aimed at establishing a strong, hierarchical social order.

Second, engineers compared with people in other disciplines should also manifest *more radical views*. This prediction too should be verifiable independently of Islamism.

Engineers' political and religious views

We searched for evidence to test the latter by trying to discover whether there is anything unusual in engineers' political-ideological orientations. The best data we could find in this regard comes from a survey of faculty members in undergraduate colleges and universities throughout the United States carried out in 1984 (Carnegie Foundation 1984).[10] Of the 9,968 faculty sampled 5,057 (50.7 %) returned completed mail questionnaires. We selected the males and

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[10] Unfortunately, there is a surprising dearth of data on type of degree in surveys that include questions about political or religious orientations. In the many surveys around the world that we checked, the type of degree is not recorded; and in the very few cases in which it is, the number of graduates is either too small or the relevant opinions are not recorded.

looked at their self-reported political and religious views according to their highest degree.

The results are startling (Table VII). The proportion of engineers who declare themselves to be on the right of the political spectrum is greater than in any other disciplinary group: 57.6 % of them are either conservative or strongly conservative, as compared to 51.1 % of economists, 42.5 % of doctors and 33.5 % of scientists, 21.4 % of those in the humanities, and 18.6 % of the social scientists, the least right-wing of all disciplinary groups. Only 1.4 % of engineers are on the left, as opposed to 12.9 % in the social sciences and 16.7 % in law. Perhaps this is an uncanny coincidence, but the four fields at the top of the conservatism scale – engineering, economics, medicine, and science – are the same four secular fields we found at the top of our main jihadist sample.

This finding is not new. In an article in *Science*, Ladd and Lipset (1972) uncovered the same result using an earlier and much larger survey of the Carnegie Foundation on American academics carried out in 1969. ''No other variable, we have found'', they concluded, ''differentiates politically among American academics as effectively as their professional field'' (*ibid.*, p. 1091). This seems a strong indication that choice of degree is a powerful proxy for ideological preferences.

The Carnegie survey reveals an even more surprising fact, hitherto unnoticed, that strengthens the suspicion that the engineers' mindset may play a part in their proneness not only to radicalise to the right of the political spectrum, but do so *with a religious slant*: engineers turn out to be by far the most religious group of all academics – 66.5 %, followed again by 61.7 % in economics, 49.9 % in sciences, 48.8 % of social scientists, 46.3 % of doctors and 44.1 % of lawyers. Engineers and economists are also those who oppose religion least (3.7 % and 3.0 %, Table VIII).

The gap between engineering and the other disciplines shows even more clearly if we consider political *and* religious views jointly (Table IX, first column): nearly half of the engineers in the sample are both conservative *and* religious (46 %), followed by economists and, at quite some distance, by doctors and scientists.

We also tested the effect of the various university degrees on the probability of being both conservative *and* religious through a logistic regression, which allowed us to control for other variables (Table X). It turns out that the odds of being both religious *and* conservative rather than anything else are *seven* times greater for engineers relative

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TABLE VII
Percentage distributions of self-reported political views of US academics
by highest degree achieved, males only

	Left	Liberal	Middle of the road	Moderately conser-vative	Strongly conser-vative	Total
Engineering	1.4	20.3	20.7	41.9	15.7	100 (217)
Economics & Business	2.1	15.3	31.5	40.0	11.1	100 (235)
Medicine	5.2	27.9	24.4	37.8	4.7	100 (172)
Natural sciences	3.6	34.4	28.63	30.0	3.5	100 (751)
Law	16.7	36.1	22.2	25.0	0.0	100 (36)
Arts & Humanities	8.8	41.8	28.0	18.7	2.7	100 (679)
Social sciences	12.9	49.7	18.8	15.0	3.6	100 (394)
Total	6.5 (161)	35.4 (879)	26.1 (648)	27.0 (670)	5.1 (126)	100.0 (2,484)

Source: Our elaboration on Carnegie Foundation National Survey of Higher Education 1984.

to the odds of a social scientist – far higher than those for any other subject.

Objections

The sources of this extraordinary bias are a puzzle in their own right. But the first question that concerns us here is whether this has anything to do with our phenomenon. Three objections could be raised.

One could question whether this mindset is unique to *academic* engineers. The answer is likely to be negative: similar results are found on the political and religious opinions of students, both for ''un-socialised'' beginners in the first four semesters and more advanced ones. While the proportions are lower than among academics the

TABLE VIII

Percentage distributions of self-reported views on religion of US academic by highest degree achieved, males only

	Opposing religion	Indifferent to religion	Moderately religious	Deeply religious	Total
Engineering	3.7	29.8	51.6	14.9	100 (215)
Economics & Business	3.0	35.3	47.2	14.5	100 (235)
Natural sciences	11.8	38.3	37.3	12.6	100 (747)
Arts & Humanities	7.5	34.6	42.8	15.2	100 (683)
Social sciences	9.3	41.9	41.7	7.1	100 (396)
Medicine	6.2	47.5	35.6	10.7	100 (177)
Law	5.9	50.0	35.3	8.8	100 (34)
Total	8.2	37.6	41.5	12.6	100 (2,487)
	(204)	(936)	(1,033)	(314)	

Source: Our elaboration on Carnegie Foundation National Survey of Higher Education 1984.

ranking is exactly the same, with engineers firmly at the top (see Table IX below, columns 2 and 3, also Ladd and Lipset 1975, pp. 74-75).[11]

Still, one could further object, the phenomenon could be uniquely *American*. Some old evidence suggests that at least the right-wing bias occurs in the Middle East: a 1948 survey of 3,890 Cairo University students recorded the highest sympathies for fascist ideology among engineering students (Botman 1984, p. 70). A survey of Canadian professors also found that engineers are the least liberal of all (Nakhaie and Brym 1999).

Unfortunately, non-US data that would allow us to combine political and religious attitudes are of much lesser quality. The International Social Survey Programme's 1998 survey was the only source we found to cover both. The ISSP has been producing a series of annual cross-national opinion surveys on samples of the general population, in which each year is focused on a different social and political topic; 1998 was the most recent set to focus on religion and also to include information on

[11] The date of this survey can be obtained at ICPSR, at the University of Michigan, www.icpsr.umich.edu/.

TABLE IX
Proportions of subjects who are both conservative and religious as opposed to anything else, among academics, graduates and undergraduates, males only (percentages)*

	Academics N = 2,456	Graduates N = 18,241	Undergraduates* N = 25,377
Engineering	46.0 (99)	27.2 (833)	16.5 (641)
Economics & Business	34.6 (80)	25.5 (768)	14.3 (545)
Medicine	24.9 (43)	22.3 (417)	–
Sciences	21.8 (161)	18.0 (760)	12.9 (846)
Arts & Humanities	14.6 (98)	11.0 (260)	9.4 (551)
Law	14.3 (5)	13.1 (199)	–
Social sciences	11.0 (43)	8.6 (187)	6.3 (332)

Source: Our elaboration on two Carnegie Foundation National Surveys of Higher Education, 1984 for academics and 1969 for graduates and undergraduates.

the position of respondents on the left-right political spectrum. As there was no information on type of degree, we were forced, however, to use various engineering-related professions as a proxy for an engineering education.[12]

The results from 2,816 cases in 16 mostly Western countries show that engineers were not more religious than other graduates and only insignificantly to the right of them. However, the *combination* of the two characteristics occurred far more often among engineers than the null hypothesis of non-correlation would predict – the only professional category in which this happened. Whereas based on individual scores on religiousness and right-wing attitudes we expected 9.4 % of engineers to share both attributes, 13.9 %, actually did (significant at 0.05). This shows that at least a minority group within a larger category displays the characteristic biases we found in the American data. This is all we need to warrant our claim that, on the margin, engineers differ in the crucial traits of religiosity *and* conservatism.

Lastly, while striking in general, in which way could this combined bias explain engineers' attraction to radical Islamism in particular? An affinity can be assumed between higher levels of religiousness and attraction by Islamist militancy, but what about right-wing attitudes? Engineers' more extreme political preferences may explain why we

[12] Professions in the survey were coded according to the 1988 ISCO classification.

TABLE X
Probability of being both conservative and religious, logistic regression coefficients, males only (N = 2,365)

	Coefficients	Significance	Exponentials
Age in years	.019*	.001	1.019
Married	.291	.089	1.338
Children	−.017	.983	.983
Engineer	1.953*	.000	7.053
Economist	1.443*	.000	4.233
Scientist & doctor	.811*	.000	2.251
Lawyer	.345	.540	1.411
Art & humanities	.208	.305	1.231
Excellent department	.350*	.008	1.419
Not published last 2 years	.401*	.003	1.493
Not expecting publications	.504*	.000	1.655
Constant	−2.585	.000	.075

-2 Log likelihood ratio 2196.939
R square (Cox & Snell) .093

find them among right-wing extremists and virtually never among left-wing ones, but why should it help us to explain their attraction to *Islamism*?

An answer is that radical Islamists' *Weltanschauung* demonstrably shares several features with the worldviews found in the extreme right. One such feature is a corporatist and mechanistic view of the ideal society. Extremist Islamist literature rejects Western pluralism and argues for a unified, ordered society ruled by a strong Islamic leader, in which an unassailable division of labour is created between men and women, Muslims and non-Muslims, political leaders and their flock. The fear of social chaos undermining this established order is a leitmotif of Islamist thought (Hoffman 1995, pp. 218 *sq.*).

Unlike left-wing extremism, which aims at broadening the lines of power and privilege, right-wing extremism aims to restore a lost, often

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mythical order of privileges and authority, and emerges as a backlash against displacement or status deprivation in a period of sharp social change (Lipset and Raab 1971). In its underlying craving for a lost order, its match with radical Islamic ideology is undeniable: the theme of returning to the order of the prophet's early community is omnipresent in most salafist and jihadist texts.

Nature of the mindset

What exactly about engineers' mindset or cognitive disposition could make them a good match for this ideological cocktail? We can conjecture that engineering as a degree might be relatively more attractive to individuals seeking cognitive ''closure'' and clear-cut answers as opposed to more open-ended sciences – a disposition which has been empirically linked to conservative political attitudes (Jost *et al.* 2003; Amodio *et al.* 2007). Engineering is a subject in which individuals with a dislike for ambiguity might feel comfortable. According to Nilufer Göle, engineers in (peaceful) Islamist parties in Turkey claim to know the ''one best way'' of how to solve social problems through technical and logical approaches, and despise the Kemalist elite of jurists who are preoccupied with debates on abstract ideas (Göle 1990, pp. 172 *sq.*). Olivier Roy, aiming to explain why many Islamist intellectuals have a scientific or technical education, points out that the sciences, in these writers' simplistic perception, reflect the ''the coherence of the whole, the rationality of the one [God]'' (Roy 1990, p. 271; Hanafi 1997, p. 148). By contrast, they refuse Western social sciences because these disciplines challenge the unity and divine order of the world.

There is some evidence of recruitment being based precisely on individual traits coherent with such dispositions. The ''constitution'' of al-Qaeda from the late 1980s says that members should ideally have a college degree (Wright 2006, p. 42), and a training manual for jihadists mentions a series of specific traits that recruiters seek: ''discipline and obedience, patience, intelligence'' (p. 18), ''caution and prudence'' (p. 19), and ability ''to observe and analyze'' (p. 20).[13] According to a British intelligence dossier (*The Sunday Times*, 10 July 2005), Islamic

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[13] ''Military Studies in the Jihad against the Tyrants'', used in court in the trial, held in New York from January to May 2001, against four men charged in the 1998 embassy bombings in East Africa. Identified in the trial files as ''Government Exhibit 1677''. Date and author are unknown.

> extremists are known to target schools and colleges where young people may be very *inquisitive* but *less challenging* and more susceptible to extremist reasoning/arguments. (*The Sunday Times*, 10 July 2005, our emphasis)

The dossier's choice of adjectives is interesting: we can find people who are inquisitive *and* challenging or supine *and* unchallenging; however, the combination of a sharp mind with a loyal acceptance of authority may exist among accountants, but is unlikely to be common among those ready to choose extreme paths. These traits that recruiters seek could be more frequent, at least marginally, among engineers, and recruiters themselves might be aware of this. The British intelligence dossier further states that

> a network of 'extremist recruiters' is circulating on campuses targeting people with 'technical and professional qualifications', particularly engineering and IT degrees.[14]

Abuza reports a similar recruitment strategy for Indonesia's Jemaah Islamiyah (Abuza 2006, p. 78).

Are these traits due to nature or nurture? Our evidence on freshmen students (Table IX) indicates that individuals with specific political and religious views, arguably reflecting an underlying forma mentis, self-select into engineering programs, rather than come to their courses *tabula rasa*. The education they receive is unlikely to correct for the traits discussed above. Friedrich von Hayek, in 1952, made a strong case for the peculiarity of the engineering mentality, which in his view is the result of an education which does not train them to understand individuals and their world as the outcome of a social process in which spontaneous behaviours and interactions play a significant part. Rather, it fosters on them a script in which a strict ''rational'' control of processes plays the key role (Hayek 1952, pp. 94-102): this would make them on the one hand less adept at dealing with the confusing causality of the social and political realms and the compromise and circumspection that these entail, and on the other hand inclined to think that societies should operate in an orderly way akin to well-functioning machines – a feature which is reminiscent of the Islamist engineers in Nilufer Göle's account. ''It is not surprising'', Hayek prophetically concluded,

> that many of the more active minds among those so trained sooner or later react violently against the deficiencies of their education and develop a passion for imposing on society the order which they are unable to detect by the means with which they are familiar. (Hayek 1952, p. 102)

[14] www.timesonline.co.uk/tol/news/uk/article542420.ece (accessed Oct 2006).

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9. *Frustrated ambitions*

Even if it could be proven beyond dispute, the mindset hypothesis cannot be the whole story. Why is the link between Islamic radicalism and engineering absent in Saudi Arabia? And, given their putative right-wing inclination, what can explain the strong presence of engineers among *left-wing* extremists in 1970s Turkey and Iran, and their moderate presence in the Palestinian Fatah, contrary to their glaring absence everywhere else in this type of groups? These ''anomalies'' indicate that the social conditions in Islamic countries are likely to play a key part in explaining the patterns of radicalization.

The position of engineers in Middle Eastern and North African countries

Researching Middle East educational systems we encountered time and again a prominent feature of engineering: together with medicine and natural sciences, it is the most prestigious subject and has high entry requirements.[15] Enrolling in an engineering degree is a strong sign of above-average talent and ambition. A degree in engineering carries more than a mere technical expertise, but also high social status (Cornand 1990; Wickham 2002). Many students choose it as much because of their interest in the subject as because of the prestige it confers (Hanafi 1990, p. 173). ''Muhandis'', engineer, is a title of honour in Arab countries.

Many Middle East regimes entertained a technocratic rhetoric of development and actively encouraged the growth of technical faculties and the mass enrolment of students (Richards and Waterbury 1996, pp. 133-142). Even more than other elite subjects engineering has had a special attraction. It is of more direct practical value, it conveys an established solidity lacking in more academic pursuits, and arguably does not lead one to challenge traditional religious tenets (Chehabi 1990, pp. 89 *sq.*).

Individuals with above-average skills selected on merit are, one would expect, particularly exposed to the frustration and the sense of injustice that comes from finding their professional future hampered by lack of opportunities. This happened on a large scale as a result of

[15] MOORE 1994, p. 46 *sq.*; CORNAND 1990, p. 192; SONBOL 1988, pp. 26 *sq.*; KEPEL 1993, pp. 136 *sq.*

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the economic and technological development failures that Middle Eastern countries have witnessed since the 1970s.[16] A particularly painful economic crisis set in with the collapse of oil prices after 1982, right around the time at which many engineers in our sample went through university and became radicalised. The effect of the lack of opportunities was intensified by corrupt, state-driven job allocation.

> For the [Egyptian] graduates who had been socialized to view themselves as a meritocratic elite, perhaps the greatest source of bitterness was what they perceived as an erosion of the link between merit and reward. (Wickham 2002, p. 159)

It appears that engineers' and OEDs' high ambitions and high frustration collided. They felt duped by the development rhetoric of their regimes and felt they deserved more than they could get. They were not just frustrated on a self-interested level, but felt unable to discharge a *collective* responsibility in modernizing Islamic countries, to live up professionally to their role as ''vanguards'' of society in which their regimes had cast them (Wickham 2002, p. 32; Apter 1965, pp. 219 *sq*.). This negative experience is a plausible factor that contributed to their radicalisation. While it was felt more by people with higher education than by the rest of the population, and could thus explain the general over-representation of the highly educated among Islamic radicals, it was felt even more strongly by the high achievers. This negative experience is a very plausible factor that contributed to their radicalisation. Detailed accounts of Egypt's education, development, and labour market history fit this explanation perfectly and link it explicitly to radicalization of university graduates.[17] Engineers' declining socio-economic status and frustrations after the 1970s are well-documented for a number of Arab countries.[18]

These signs point to a classic explanation of the onset of rebel movements – *frustrated rising expectations* and *relative deprivation* – dating back to Aristotle and Tocqueville (Davies 1962; Gurr 1970). This explanation has been traditionally used to explain inter-country differences in radicalisation, while in this case it could account not so much for the emergence of the movement as a whole as for the social composition within each country's radical sector. It could explain why more graduates generally radicalised in the Middle East and why more engineers and OEDs in particular did so, even in the case of several

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[16] LONGUENESSE 1990; OXFORD ANALYTICA 2006; UNDP 2003, pp. 97-109.

[17] IBRAHIM 1980; MOORE 1994; KEPEL 1993; WICKHAM 2002.

[18] *Cf*. LONGUENESSE 1990, 2000; AKKACHE 1990; HANA 1990; CORNAND 1990.

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leftist movements. Conversely, it could also explain why in the West and in Singapore, both of which unlike Middle Eastern countries have seen very successful economic development, much fewer graduates are found among radicals.

The Saudi exception

If frustration with dismal professional opportunities indeed contributed to their radicalization, we should find fewer radical engineers where conditions were more favourable. This is exactly what the exception of Saudi Arabia seems to demonstrate. Saudi Arabia is the only nation whose violent radicals show no over-representation of engineers in our sample. There is very good evidence that Saudi engineers have had much better labour market chances than their peers in any of the non-Gulf Middle Eastern states. The Saudi market has long been able to absorb all its graduates from prestigious technical subjects. The Saudi private sector has time and again petitioned the government to produce more graduates with technical education.[19] As the human resources manager of a large Saudi bank told one of us, in contrast to other countries where business graduates are the most sought after, their first recruitment target was engineers.[20] With such favourable labour market conditions it is even surprising that we still find two engineers in our samples.

Repression and resentment

We now have the elements of a potentially explosive mix. However, this would have remained inert had it not been for one crucial factor: the harsh repression on the part of the authoritarian Islamic governments, which by all accounts played a crucial role in inducing radicalisation generally regardless of the engineering phenomenon.

In Turkey, a country in which both democratic institutions and economic development have been in relatively better shape, we find fewer violent Islamic extremists of any kind. Elsewhere, repressive and corrupt regimes that failed to live up to their developmental promises narrowed the openings for frustrated elites to manifest their opposition.

[19] Interviews with private sector representatives, Riyadh, 2003 to 2005.
[20] Interview with Norlida Azmi, assistant general manager, SAMBA Financial Group, Riyadh, December 2005.

Other than acquiescence, joining radical movements became the only option (Hafez 2003; Wiktorowicz 2004).

By itself, however, repression cannot explain the overrepresentation of engineers, as it could have affected individuals with other degrees. Its specific effects could be of two kinds: either engineers were already overrepresented among the opposition movements targeted by repression and became radicalised by the experience just like everyone else; repression would thus be relevant for everyone whether engineers or non-engineers in the same way. Or engineers were not initially overrepresented among those who suffered from repression, but responded to it in a more extreme way; in this case repression might have interacted with the mindset leading more engineers to become violent extremists. The stronger presence of OEDs among peaceful Islamist movements makes the latter more plausible for in so far as repression targeted Islamic movements of all descriptions, OEDs too should have been exposed to it.

To be relevant for our puzzle, repression and Islamic radical ideology must have interacted with ''the engineering mindset'' in a special way. By canvassing a stricter version of the religion, it offered the best available opportunity to strengthen the flagging confidence of aspiring elites vis-à-vis Western technical and cultural supremacy, and became the haven for frustrated individuals of high potential. Islamic ideology proved a peculiarly well-suited means to reduce the cognitive dissonance and turn resentment into a political resource. Its cocktail of tradition and modernization might have been a particularly good match for engineers. This is arguably the crucial juncture at which the effects of frustrated expectations, individual as well as collective, joined forces with the engineering mindset. Where would-be militant engineers had the choice between joining a secular and traditional leftist group or an Islamic one, they chose the latter in greater numbers: in 1970s Iran, humanities and social science students dominated among Marxist guerrillas, whereas ''physical sciences'' dominated among the Islamo-Marxist Mojahedin E-Khalk (Hoffman 1995, p. 206). And in Palestine proportionally many more engineers opted to join Hamas than secular Fatah.

10. *An overview*

The most plausible explanation of the engineers' over-representation among violent Islamic radicals everywhere lies in the joint effect of two causes. Without the severe lack of professional opportunities that they had to endure in Middle Eastern countries we would not find

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an over-representation of graduates, especially from elite degrees, among violent Islamic radicals – as indeed we do *not* find it either in the West, in Singapore or even in Saudi Arabia where we know that graduates fared much better professionally. This pattern clearly points to the importance of relative deprivation and frustrated expectations, a theory that may have been abandoned too hastily, partly perhaps because it was applied at too macro a level, that is to explain country rather than group differences.

However, without their mindset, which inclines them to take more extreme conservative and religious positions everywhere, even in Middle Eastern countries engineers would have behaved as those with OEDs, largely limiting themselves to non-violent forms of radicalisation. The mindset could also explain why even in the Western and South East Asian groups in which graduates did not experience the same professional frustration they had in Middle Eastern countries, the engineers' overrepresentation is strong: even if there are very few graduates, most of them are engineers. In the case of the Middle East, deprivation and mindset seem to have worked together, selecting elite graduates first and then engineers among them, which could explain the much larger scale of the phenomenon, while in the West and in Singapore mindset alone seems to explain the phenomenon, which in absolute terms is much smaller.

The only other case in which we find a trace of engineers' prominence outside of Islamic violent groups is, consistent with the mindset hypothesis, among the most extreme right-wing movements, especially in the US and in Germany, where it is all the more striking again given the general low level of education of the members of such groups. Here we have perhaps the only other case in which the mindset alone has activated engineers into resorting to violent action – their absolute number is tiny, but disproportionate relative to other types of graduates.

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Résumé

L'article montre que parmi les terroristes islamistes de par le monde, les ingénieurs et titulaires d'un diplôme d'enseignement supérieur scientifico-technique sont trois à quatre fois plus nombreux que selon leur part dans l'ensemble des diplômés supérieur. Différentes hypothèses sont explorées. La combinaison de deux facteurs – frustration relative des ingénieurs dans le monde islamique et état d'esprit semble fournir l'explication la plus plausible.

Mots clés : Jihad ; Islamisme ; Ingénieurs ; Violence politique ; Frustration relative.

Zusammenfassung

Der Aufsatz zeigt, daß weltweit unter militanten Islamisten mit Hochschulausbildung der Anteil der Ingenieure drei bis viermal hoeher ist, als man dies aufgrund der relativen Groeße verschiedener Fakultaeten in den Herkunftslaendern erwarten wuerde. Die Kombination zweier Faktoren – relative sozio-ökonomische Frustration der Ingenieure in der islamischen Welt und Eigenheiten ihrer Denkweise – scheint die plausibelste Erklärung zu sein.

Schlagwörter: Djihad; Islamismus; Ingenieure; Politische Gewalt; Erziehung; Relativer Verlust.