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Supplementary Information

Local alliances and rivalries shape near-repeat terror activity of al-Qaeda, ISIS and insurgents

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1988	Osama bin Laden founds AQ
1999	Abu Musab al-Zarqawi establishes JTJ
2001	JTJ moves its base to Iraq
Oct 17, 2004	JTJ is renamed AQI and joins AQ
Jan 15, 2006	AQI and other five groups form MSC
Oct 15, 2006	ISI is officially established
Apr 8, 2013	ISI is renamed ISIS and expands into Syria
Feb 2, 2014	AQ formally disavows ISIS

Table S1. Timeline of relations between AQ and ISIS.

Supporting Information Text

AQ and ISIS affiliates, and L-class groups in the GTD

Table S1 summarizes key events in the history of al-Qaeda (AQ) and ISIS, as described in the main text. Our attack data is taken from the Global Terrorist Database (GTD) available from the National Consortium for the Study of Terrorism and Responses to Terrorism (START) which lists events between Jan 1 1970 and Dec 31 2017. According to the GTD codebook, an event must meet two of the following three criteria to qualify as a terrorist attack: (1) it must have political, religious, or socioeconomic goals; (2) its intent must be to intimidate or coerce an audience larger than the immediate victims; (3) it must fall outside legitimate warfare activities, for example by deliberately targeting civilians. Conventional military actions are not included. Each entry contains time and location of the attack, name(s) of the perpetrator group(s), number of victims, weapon/target types, among others.

AQ and ISIS affiliates. The first AQ entry recorded in the GTD is dated 1992 and took place in Yemen; the first ISIS attack is dated 2003, and was carried out by its predecessor Jamaat al-Tawhid wal-Jihad (JTJ) in Iraq. Several challenges arise in identifying AQ and ISIS affiliates. First, they may have used various names and/or spellings depending on geopolitical context. Spellings may also depend on the sources reporting terrorist activities. For example al-Qaeda is also translated as al-Qaida, al-Qa'ida, or el-Qaida, and ISIS at times is referred to as ISIL (Islamic State of Iraq and the Levant). The GTD unified the English translation of group names, listing al-Qaeda and all other variants as al-Qaida, and ISIS and all other variants as ISIL. In our work we use the GTD classification but the more common versions al-Qaeda (AQ) and ISIS. Second, these global terrorist groups may have incorporated (rejected) local groups into (from) their networks at given points in time, as dictated by circumstances; some associations may not even be fully clear due to the covert nature of terrorist activities. In our work, only groups that were officially accepted by AQ or ISIS into their networks, and for which verifiable documentation is available, are listed as affiliates. Furthermore, we list them only for the period during which such recognition was granted. For example al-Shabaab of Somalia or Boko Haram of Nigeria joined AQ and ISIS, respectively, after their founding, are included as AQ or ISIS affiliates after their official pledge dates. Other groups that never formally pledged allegiance to either AQ or ISIS are assigned to the L class, such as the Taliban in the Afghan-Pakistan area. Finally, since ISIS predecessors were recognized as AQ affiliates between 2004 and 2014, their attacks within this period are assigned to both the AQ and ISIS classes. Between 2001-2017, 6130 (9183) attacks are associated with AQ (ISIS), 3383 (7878) of them took place post-2014. A total of 1328 joint AQ/ISIS attacks are listed between 2001-2017, of which only 72 are post-2014.

The AQ class thus includes AQ proper (59 attacks in the GTD), al-Qaeda in the Arabian Peninsula (AQAP, 1046 attacks), al-Qaeda in the Islamic Maghreb (AQIM, 282 attacks), al-Qaeda in the Indian Subcontinent (AQIS, 33 attacks), al-Qaeda in Yemen (12 attacks), al-Qaeda in Saudi Arabia (8 attacks), Islambouli Brigades of al-Qaeda (5 attacks), Jadid al-Qaeda Bangladesh (JAQB, 3 attacks), al-Qaeda Kurdish Battalions (AQKB, 2 attacks), al-Qaeda Network for Southwestern Khulna Division (2 attacks), al-Qaeda in Lebanon (1 attack), al-Qaeda Organization for Jihad in Sweden (1 attack). Groups founded under AQ's official oversight are also included, such as Jabhat al-Nusra (JN, 344 attacks) and its successor Hay'at Tahrir al-Sham (HTS, 43 attacks) in Syria, Jamaat Nusrat al-Islam wal Muslimin (JNIM, 59 attacks) in Mali. Al-Shabaab of Somalia formally merged with AQ in 2012, and their 2947 attacks from that date onward were also added to the AQ class. Between 2003 and 2014, ISIS (499 attacks) and its predecessors al-Qaeda in Iraq (AQI, 639 attacks), Mujahedeen Shura Council (MSC, 8 attacks), and Islamic State of Iraq (ISI, 147 attacks) were part of the AQ network, so we include their attacks in the AQ class during this period. The Taliban of Afghanistan is considered an independent organization rather than an AQ affiliate since, despite its well-known ties with AQ, it never formally pledged allegiance to AQ. Note that some of the events listed above are associated with multiple AQ affiliates, either as perpetrators or suspects, as a result the sum of the total number of attacks (obtained by summing the numbers in parenthesis above) slightly exceeds the 6130 total.

The ISIS class consists of ISIS proper (5676 attacks), its predecessors, and its various remote provinces or chapters. ISIS predecessors include JTJ (1999 – 2004, 47 attacks), AQI (2004 – 2013, 639 attacks), MSC (2006 – 2006, 8 attacks), and ISI (2006 – 2013, 147 attacks). Beginning in 2013, ISIS established itself outside of Iraq and Syria, through the Sinai Province (447 attacks) in Egypt, the Khorasan Chapter (396 attacks) in Afghan-Pakistan, the Tripoli Province (351 attacks), the Barqa Province (161 attacks), the Fezzan Province (10 attacks) in Libya, the Adan-Abyan Province (50 attacks), the Sanaa Province (30 attacks), the Hadramawt Province (16 attacks), the Lahij Province (4 attacks), the al-Bayda Province (2 attacks), the Shabwah Province (1 attack) in Yemen, the Caucasus Province (17 attacks) in Russia, the Algeria Province (10 attacks) in Algeria, the Najd Province (9 attacks) in Saudi Arabia, the Bahrain Province (2 attacks) in Bahrain, and a few other smaller branches in Egypt (22 attacks), Bangladesh (38 attacks), the Greater Sahara (ISGS, 11 attacks), and Jerusalem (10 attacks). Boko Haram of Nigeria and Abu Sayyaf Group (ASG) of the Philippines, respectively, joined ISIS in 2015 and 2016, and their respective 975 and 106 attacks from those dates onward are included in the ISIS class.

L-class local militias/insurgent groups. To analyze the interplay between AQ, ISIS and local militias/insurgent groups that define the L class, we identified areas where attacks from the L class co-localize with the twelve AQ/ISIS clusters identified above. We identify 38220 worldwide L-class attacks between 2001-2017, of which 19116 are post-2014. Of these, 13551 co-localize with the AQ/ISIS clusters. Here we list the names of local groups which contributed more than 20 attacks in the respective clusters post-2014:

- **Iraq cluster:** Kurdistan Workers' Party (PKK, 836 attacks, mostly in Turkey), Asa'ib Ahl al-Haqq (56 attacks), Badr Brigades (54 attacks), Al-Naqshabandiya Army (26 attacks);
- **Syria cluster:** Hamas (Islamic Resistance Movement, 102 attacks), Free Syrian Army (92 attacks), PKK (59 attacks), Ansar Bayt al-Maqdis (Ansar Jerusalem, 42 attacks), Ajnad Misr (32 attacks), Muslim Brotherhood (32 attacks), Islamic Front of Syria (32 attacks), Jaysh al-Islam of Syria (30 attacks), Southern Front (28 attacks), Palestinian Islamic Jihad (PIJ, 22 attacks);
- **Yemen cluster:** Houthi extremists (Ansar Allah, 975 attacks), Tribesmen (56 attacks), Popular Resistance Committees of Yemen (25 attacks), Southern Mobility Movement of Yemen (21 attacks);
- **Nigeria cluster:** Boko Haram (before joining ISIS, 615 attacks), Fulani extremists (429 attacks);
- **Afghan-Pakistan cluster:** Taliban (4128 attacks), Tehrik-i-Taliban Pakistan (TTP, 401 attacks), Baloch Republican Army (BRA, 147 attacks), Hizbul Mujahideen (HM, 109 attacks), Lashkar-e-Taiba (LeT, 101 attacks), Baloch Liberation Army (BLA, 68 attacks), United Baloch Army (UBA, 58 attacks), Lashkar-e-Islam of Pakistan (47 attacks), Baloch Liberation Front (BLF, 42 attacks), Jaish-e-Mohammad (JeM, 42 attacks), Lashkar-e-Jhangvi (42 attacks), Haqqani Network (31 attacks), Halqa-e-Mehsud (24 attacks);
- **Libya:** Ansar al-Sharia of Libya (55 attacks), Haftar Militia (25 attacks);
- **Mali cluster:** Ansar al-Dine of Mali (48 attacks), Macina Liberation Front (FLM, 28 attacks), Movement for Oneness and Jihad in West Africa (MUJAO, 24 attacks);
- **Philippines cluster:** New People's Army (NPA, 1028 attacks), Bangsamoro Islamic Freedom Movement (BIFM, 296 attacks), Abu Sayyaf Group (ASG, before joining ISIS, 175 attacks), Maute Group (34 attacks);
- **Bangladesh cluster:** Communist Party of India - Maoist (CPI-Maoist, 204 attacks), Pro Hartal Activists (91 attacks), Garo National Liberation Army (77 attacks), United Liberation Front of Assam (ULFA, 72 attacks), Gorkha Janmukti Morcha (GJM, 70 attacks), Communist Party of Nepal - Maoist (CPN-Maoist-Chand, 66 attacks), National Democratic Front of Bodoland (NDFB, 53 attacks), National Socialist Council of Nagaland-Isak-Muivah (NSCN-IM, 51 attacks), National Socialist Council of Nagaland-Khaplang (NSCN-K, 48 attacks), Arakan Rohingya Salvation Army (ARSA, 46 attacks), People's Liberation Front of India (44 attacks), People's Liberation Army of India (40 attacks), Jamaat-E-Islami of Bangladesh (39 attacks), Bangladesh Nationalist Party (BNP, 23 attacks), Achik Songna An'pachakgipa Kotok (ASAK, 20 attacks), Rohingya extremists (20 attacks);
- **Somalia, U. S., Algeria/E. U. clusters:** N/A.

k-means clustering analysis

We examined the spatial distribution of attacks in the AQ and ISIS classes defined above through geographic clustering. We used the k-means algorithm which assigns each event, in this case an AQ or ISIS attack, to one of k clusters by iteratively updating the centers of these clusters and minimizing the root-mean-square distance $\bar{d}_k$ between the event location and its assigned cluster center (1). The number of clusters k is a prescribed parameter for the algorithm; $\bar{d}_k$ decreases as k increases, as shown in Fig. S1(a), and is exactly zero when k equals the total number of events, since in this case the location of each event becomes its own cluster center. Although the goal of minimizing $\bar{d}_k$ favors the choice of a large k, decreases in $\bar{d}_k$ as k increases may become negligible beyond a threshold value k^*, indicating that new clusters are not distinguishable from old ones. The optimal k^* is often determined by plotting $\bar{d}_k$ as a function of k and identifying the value of k beyond which it begins to plateau. Fig. S1(b) illustrates how we quantitatively identify k^*. We first define $I_k \equiv |\bar{d}_{k+1} - \bar{d}_k|/\bar{d}_k$ as the relative change in $\bar{d}_k$ as the number of clusters is increased from k to $k+1$ and plot I_k versus k. We find that I_k decreases from about 10% to about 5% when k increases from 12 to 13 and stays well below 10% as k further increases. We thus set $k^* = 12$ as the optimal number of clusters. When $k = 13$, the Somalia cluster is split in two due to its elongated geographic shape; since all attacks in Somalia have been attributed to AQ-affiliated al-Shabaab, the cluster should be unique, confirming that $k^* = 12$ is the optimal k value. We set a threshold of at least 100 post-2014 data points per cluster to justify further analysis. According to this definition, among the twelve identified above only six contain enough data to be used for our near-repeat analysis.

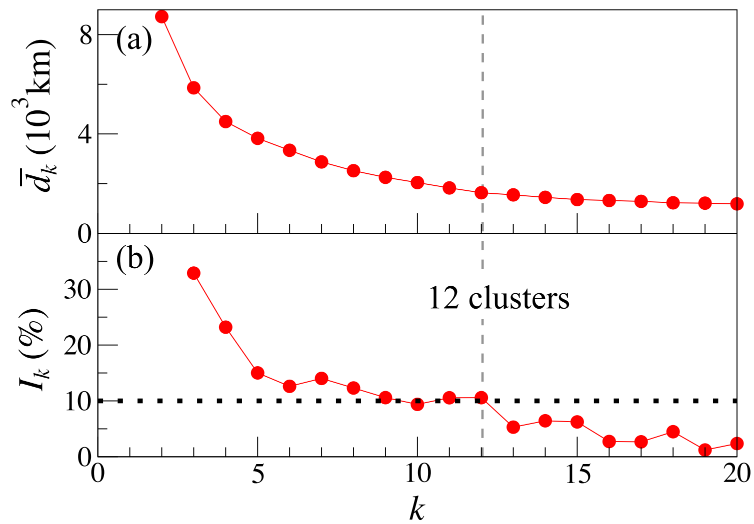

Fig. S1. Determining the optimal number of clusters k^*. Panel (a) shows that the root-mean-square distance $\bar{d}_k$ from an attack location to the center of its assigned cluster decreases as the number of clusters k increases. In Panel (b) we compute the relative change I_k when the number of clusters increases from k to $k+1$. When $k > 12$, I_k drops noticeably from $\gtrsim 10\%$ to $\lesssim 5\%$; we thus identify $k^* = 12$ as the optimal number of clusters.

They are Iraq, Somalia, Syria, Yemen, Nigeria, and Afghan-Pakistan. Of the others, five clusters have too few attacks for any statistically significant analysis; they are Mali, Algeria/E.U., Bangladesh, the Philippines, and the U.S. The Libya cluster has relatively more data points than the previous five, but the attacks are sparsely distributed on a vast area, yielding an insufficient number of closely separated pairs for us to analyze.

As seen in Fig. 1 of the main text, the twelve clusters are roughly limited by geo-political boundaries and few attacks occur near the borders; this allows us to name each cluster by the country where the majority of attacks took place. It is important to note that our k-means clustering uses only attack-location as input and that we did not pre-impose that clusters be limited by national borders, rather their geographic extent emerged naturally. To verify the robustness of our clustering, we varied the random number sequence of the k-means algorithm seeding the initial cluster centroids, and found that the spatial extent of the clusters remained consistent across runs. While most clusters coincide with a single country, a few contain parts of a neighboring one due to porous frontiers, or shared political and/or historical traits, showing that diffusion of terrorism across boundaries may be possible under specific geographical conditions (2). For example, Lebanon is clustered with Syria due to spill over-effects of the Syrian civil war into Lebanon facilitated by fluid boundaries between the two. Similarly, since AQ used Somalia as a base to launch attacks against Kenya, the two are part of the same cluster. The Nigeria cluster includes a small area between neighboring Chad, Niger and Cameroon where occasionally Boko Haram has spilled over due to border porosity. Afghanistan and Pakistan are in the same cluster due to militant groups residing in the tribal corridor between the two, particularly in North and South Waziristan: the Tehrik-i-Taliban Pakistan (TTP) and the Khorasan Chapter of ISIS. Finally, attacks in Algeria, Tunisia and the E.U. coalesce into one cluster due to the small, uncoordinated, number of attacks on European soil and in Tunisia which are geographically closest to the denser ones in Algeria. For the most part however attacks are mostly confined within nation states. This may be due to increased military security at the border, or because borders coincide with natural barriers such as mountain ranges, deserts or rivers where terrorist events would cause fewer victims, elicit less interest from the press, and garner less attention from the population. Another possible reason is that terror groups prioritize attacks on "soft" targets where large numbers of civilians aggregate and these are mostly located in major cities, typically in the interior. Furthermore, terrorists may prefer to act in familiar settings, responding to local sources of discontent and grievances (3–5). Also note that while AQ and ISIS both aim for the supremacy of Islamic values, they also establish themselves in territories with pre-existing militant groups that carry different sources of discontent, instabilities, antipathies, that have existed for much longer periods than the advent of either, so that regionality is to be expected on some level. Finally, AQ is flexible and operates as a geographically diffused network of semi-autonomous cells, allowing for regionality to emerge by design. ISIS is more centralized, yet as it conquered or accepted groups that pledged allegiance to it, it divided its territory into provinces, factoring in pre-existing conflicts and geographical constraints. Indeed, the provinces often coincide with the countries (or subnational units) they are based in. So although AQ and ISIS are transnational groups, their activities on the ground are tied to the local discourse and remain clustered mostly in well defined areas. This is also verified by the location of attacks and origin of their perpetrator groups being always in the same cluster, except for a handful of exceptions. For example, the Nusra Front and the Free Syrian Armies concentrated all of their attacks in the Syria cluster, al-Shabaab stays confined to the Somalia cluster, Boko Haram's sphere of action is the Nigeria cluster. Finally, note that we investigated possible near-reaction activities over 20km and at the borders between Syria-Lebanon, Somalia-Kenya, Afghanistan-Pakistan, and across the countries that comprise the Nigeria cluster, and found scant data due to violent attacks being executed near major cities as described earlier.

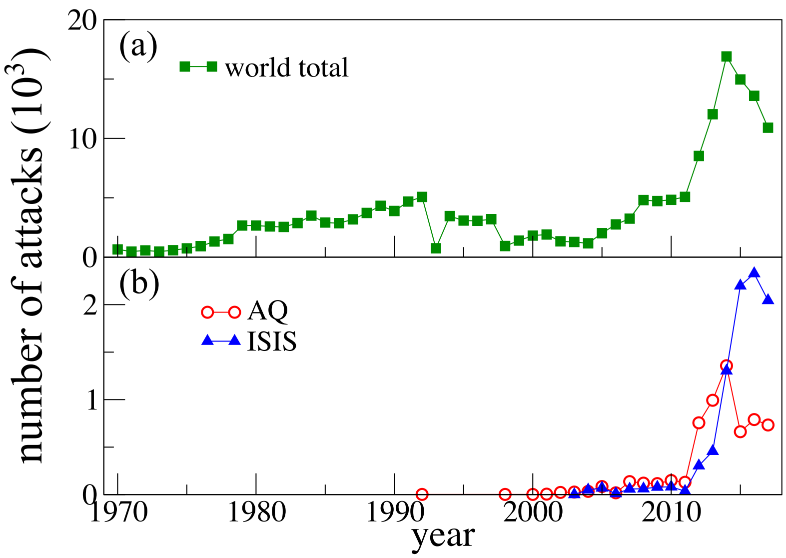

Fig. S2. Yearly number of terrorist incidents from 1970 to 2017. Panel (a) shows the total number of attacks worldwide; panel (b) plots the number of attacks attributed to AQ and ISIS including their respective official affiliates. Terrorist activities peaked in the mid 2010s and have been declining since.

AQ and ISIS in the context of global terror

Figs. S2(a) and (b) show the total number of terrorist attacks worldwide and those attributed to AQ and ISIS respectively between 1970 and 2017. The AQ and ISIS world percentages shown in Fig. 2(a) of the main text are derived from these values. The total number of global attacks increased from 1970 to the early 1990s during the so-called New-Left terrorist wave (including attacks from the Red Brigades in Italy, RAF in Germany, FARC in Colombia, and Shining Path in Peru to name a few) which faltered after the dissolution of the Soviet Union. A subsequent terrorist wave emerged from religious conflicts in the 2000s and climaxed in the 2010s. AQ and ISIS follow, and are in part responsible for, the religious terrorist wave: AQ was engaged in sporadic attacks during the 1990s, over the next decade it intensified its activities as the ISIS predecessors emerged. As a result, the number of attacks attributed to AQ and ISIS grew steadily during the 2000s and peaked in the early 2010s. The global number of terrorist attacks has been decreasing since 2015, and contributions from AQ/ISIS have stagnated since. The GTD does not report data beyond Dec 31, 2017.

Temporal overlap of AQ and ISIS activities in each cluster

Fig. S3 shows AQ and ISIS activities within each cluster as a function of time by binning terrorist incidents in six month intervals starting from 2012. What emerges is that AQ attacks mostly cease in Iraq after it disavowed ISIS in 2014. Significant AQ/ISIS overlap is observed in Syria and Yemen. In Syria, this overlap is due to ISIS expanding into the country in 2013, right before the 2014 AQ/ISIS rift (6) . In Yemen, it is due to the establishment of a new ISIS province in 2015. The twelve panels are arranged in increasing order of distance from Iraq. The first data points for ISIS emerge at later times in the lower panels, geographically further from Iraq, revealing a spreading terror "wave" for ISIS. A complementary visualization is offered in Fig. 3(b) of the main text, as well as in right panels of Fig. S4, where attacks are geo-spatially mapped every six months beginning in 2012. AQ activities in contrast manifest more random spatiotemporal variation, as can be seen from the left panels of Fig. S4. The different spatio-temporal patterns characterizing AQ and ISIS may be a reflection of their different organizational structures, as AQ may be described as a decentralized "dune-like" network of various cells, while ISIS follows a centralized hierarchy. These structural differences are related to their distinct goals and approaches (7). AQ's priority is to eliminate Western influence from the Middle East; terrorist attacks are tools to weaken their perceived oppressors. ISIS's preferred action is to expand the territories it controls, attacking unfriendly communities and non-Sunni Muslims. As a result AQ has developed a large decentralized network of collaborative relationships including with the Taliban in Afghanistan and Pakistan, with al-Shabaab in Somalia, and with Boko Haram in Nigeria. In these regions AQ rarely operates on its own, but provides logistic and financial support to local groups, largely without friction. Very few attacks can thus be directly attributed to AQ, and they are not enough to be statistically analyzed. Conversely ISIS's strategy has long been to either subordinate existing groups, as attempted with Boko Haram in Nigeria, or to establish its own terrorist province antagonizing local groups, as done in Yemen, Afghanistan and Pakistan.

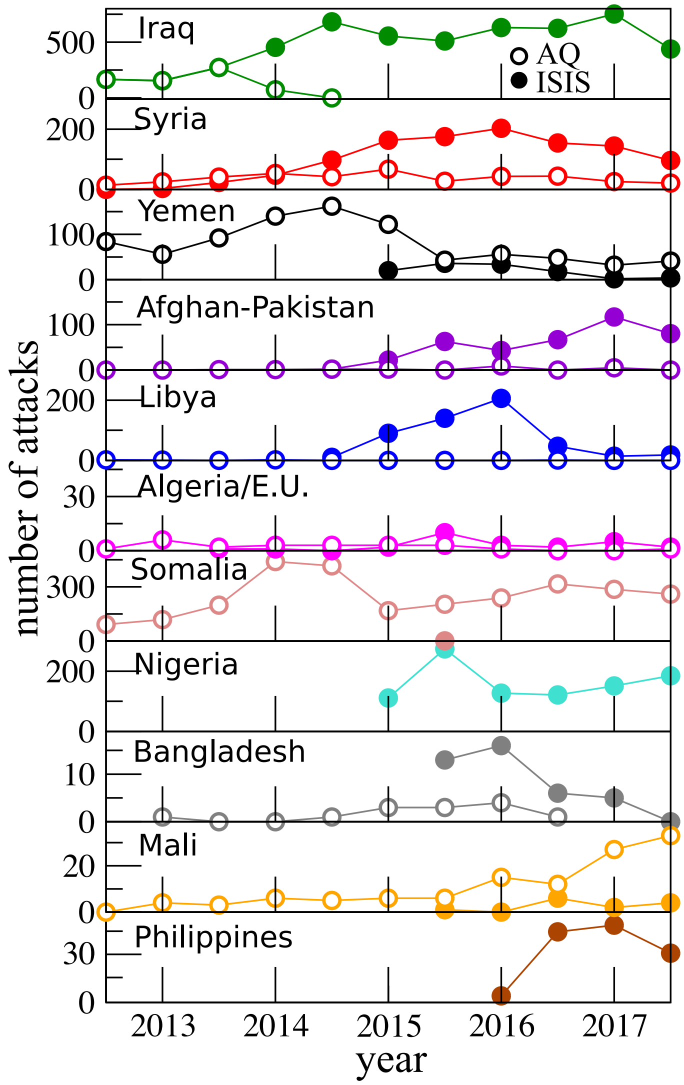

Fig. S3. Number of AQ and ISIS attacks per half year in each geographic cluster after 2012. AQ attacks are represented by open circles; ISIS attacks are denoted by solid circles. Significant temporal overlap between AQ and ISIS activity is observed in the Syria, Yemen, and Bangladesh clusters after the 2014 AQ/ISIS rift. Clusters are arranged from top to bottom in the order of their distance from Iraq. The first data point for the ISIS attacks shifts towards later times in the lower panels, revealing that ISIS spread from Iraq first to neighboring countries and later to more distant regions. This figure is complementary to Fig. 3(b) of the main text. AQ shows no such pattern and ceased to operate in Iraq post-2014.

The Kullback-Leibler Divergence and the near-repeat 20 km threshold

Converting geographic coordinates to distances. For near-repeat analysis, we need to first compute the distance between pairs of GTD events, which are recorded as longitudinal and latitudinal coordinates (x_i, y_i) for all i entries. By approximating the Earth as a perfect sphere, as illustrated in Fig. S5, we determine the distance L between two events as follows

$$L = R_{\text{Earth}}\theta, \qquad [1]$$

where the radius of the Earth is $R_{\text{Earth}} = 6373$ km and where the radiant angle between the two events is given by

$$\theta = 2\tan^{-1}\sqrt{\frac{s^2}{R_{\text{Earth}}^2 - s^2}}. \qquad [2]$$

The length of the segment s between the two events that appears in Eq. 2 is given by

$$s \quad = \quad R_{\text{Earth}}\left[\sin^2\left(\frac{y_1 - y_2}{2}\right) + \cos(y_1)\cos(y_2)\sin^2\left(\frac{x_1 - x_2}{2}\right)\right]^{\frac{1}{2}}. \qquad [3]$$

where x_i represents longitude and y_i represents latitude for the $i = 1, 2$ locations.

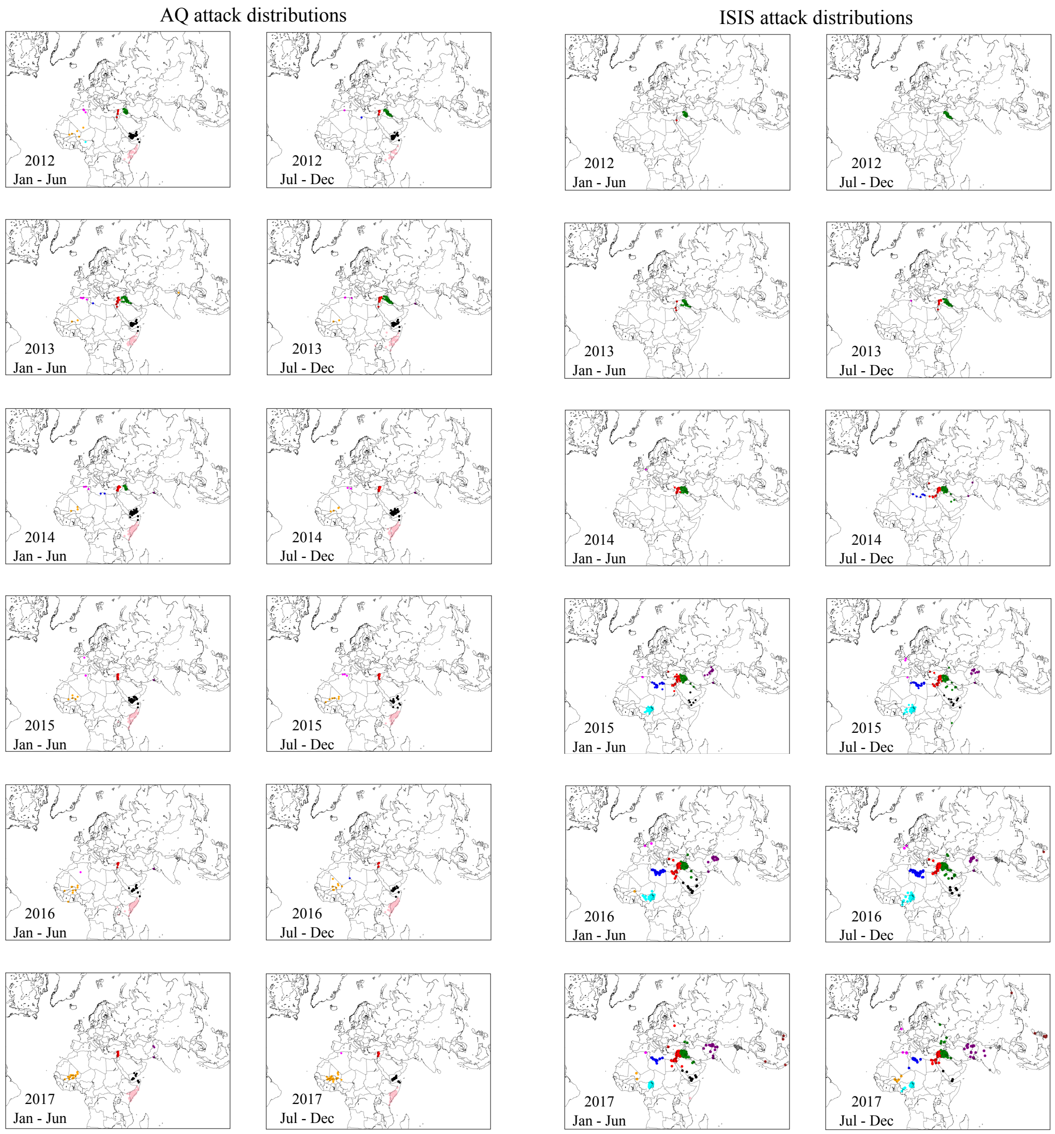

Fig. S4. Distributions of AQ and ISIS attacks in the twelve AQ/ISIS clusters plotted every six months from 2012 to 2017. AQ attacks shift around the globe, emerging and disappearing from one period to the next. In contrast, ISIS has maintained a strong presence in Iraq since 2012, and its attacks have spread out first to Syria in 2014, to other Middle-East neighboring countries in 2015, and then to more remote regions after 2016.

The Kullback-Leibler divergence. We then utilize the Kullback-Leibler divergence (KLD) to quantify discrepancies between the observed near-repeat latent time distribution and the random event hypothesis (REH) distribution given by $P_d(t)$ in Eq. 1 of the main text for pairs of events separated by a distance $L \leq d$. The KLD is defined as the Shannon entropy of the data $\{(t_i, \hat{p}_i)\}$ relative to the REH $\{(t_i, p_i = P_d(t_i))\}$

$$\text{KLD} = \sum_i E_i \equiv \sum_i \hat{p}_i \ln \frac{\hat{p}_i}{p_i}. \quad [4]$$

In Eq. 4 $E_i = \hat{p}_i \ln(\hat{p}_i/p_i)$ is the i^{th} data point contribution to the KLD, which quantifies how much $\hat{p}_i$ deviates from p_i. The prefactor $\hat{p}_i$ places greater weight on events of higher probability and reduces the contribution of fluctuations associated to rare events. The KLD values depend on d, the maximum distance between two events for which the time lag t_i can be calculated. In Fig. S6 we plot the KLD as a function of d for AQ→AQ and ISIS→ISIS near-repeat events post-2014. There are 204 weeks between Feb 2, 2014, the official AQ/ISIS rift date, and Dec 31, 2017, the last GTD entry. We calculate the KLD on a sample of four consecutive $w = 44$ week windows within the above time frame, and repeat the same procedure ten times by randomly changing the start date beyond Feb 2, 2014. The average KLD value and the error bars shown in Fig. S6 are obtained over the effective 40 samples of duration w. For both AQ and ISIS, the KLD decreases as d increases, indicating that the near-repeat tendency is stronger for events geographically closer to each other, and that the latent time distribution converges to the REH

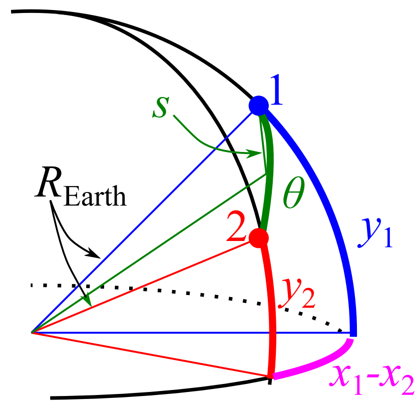

Fig. S5. Evaluation of the distance L between two geographic locations $i = 1, 2$ schematically represented by the blue and red dots. Each location is associated to (x_i, y_i) coordinates where x_i indicates longitude and y_i latitude, for $i = 1, 2$. The evaluation of $L = R_{\mathrm{Earth}}\theta$ follows Eqs. 1-3 and uses basic trigonometry.

when the underlying events are sufficiently far. In the main text we set $d = 20$km as the distance threshold within which to study near-repeat phenomena. This value of d is represented by the second point on each of the curves in Fig. S6. The first point corresponds to a 10km threshold and has the largest KLD value but also the largest error due to the fewer pairs of near-repeat events that can be constructed under a smaller upper distance limit. When $d = 20$km instead, the KLD is large enough and the error small enough, to distinguish it from KLD values at greater distances, say at 100km.

We also find it statistically significant that for attacks within 20km ISIS expresses a relatively stronger near-repeat tendency compared to AQ, since ISIS has greater KLD values than AQ and the two data points reside outside their respective error ranges. As d increases, the KLD value of AQ decreases at a slower rate than ISIS, the gap between them closes, and for distances of several hundreds of kilometers the KLD value of AQ exceeds that of ISIS. This may suggest a certain long-range coordination of AQ attacks which may be facilitated by its global network structure. We verified that all results are robust to moderate changes in w and to start dates beyond Feb 2, 2014.

For near-reaction patterns, we compute the correlation r between the $\{E_i^{\mathrm{A}\to\mathrm{B}}\}$ and $\{E_i^{\mathrm{B}\to\mathrm{A}}\}$ datasets, derived respectively from the A→B and B→A panels in Fig. 5 of the main text, where $\{\mathrm{A,B}\} = \{\mathrm{AQ, ISIS, L}\}$ and $\mathrm{A} \neq \mathrm{B}$. A positive r indicates heightened attack response probabilities for both the A and B class organizations in response to each other's attacks; this may be due to collaborative, aligned, or retaliatory copycat events, for example. Conversely a negative r implies that the attack likelihood of say, class A quickly increases in response to attacks by class B, whereas class B delays its response after attacks by class A. This asymmetry may be to to structural differences between the two classes, where for example class B requires more time to evaluate and organize response attacks to class A. One of the main findings from the main text is that when the three AQ, ISIS, and L classes are all present in a cluster, one of the transnational groups (AQ or ISIS) and the local L class emerge as major players, and are in conflict with each other. The remaining transnational group (ISIS or AQ) is instead a minor player and tends to align itself with either of the major ones. These dynamics are reflected in the post-2014 near-reaction patterns. Asymmetric A→B and B→A near-reaction activity, and a negative r are found to characterize rival organizations, where the agile, quick to respond A is the local militia/insurgent group and B the slower transnational organization (AQ/ISIS). Symmetric A→B and B→A near-reaction activity and a positive r is instead a hallmark of collaborative/aligned groups. As we shall describe below, results from pre-2014 data are consistent with the post-2014 analysis illustrated above and rival groups still manifest A→B and B→A near-reaction asymmetry. There is no distinction between AQ and ISIS in any geographical cluster pre-2014, because either they were either the same organization, or ISIS had not expanded into the region yet; as a result, no collaborative/aligned relations, and no symmetric A→B and B→A near-reaction patterns are identified. Small $|r|$ indicates weak correlation; in this case the sign of r becomes irrelevant since the two classes are essentially not responding to each other. We use conventional criteria and assume that $r \geq 0.66$ ($r \leq -0.66$) indicates strong correlation (anti-correlation), $|r| < 0.33$ represents weak correlation, and $0.33 < r \leq 0.66$ ($-0.33 > r \geq -0.66$) is indicative of intermediate correlation (anti-correlation).

Outbidding

Outbidding is the process of competitive escalation among two (or more) separate but related groups who operate in the same geographical area and who orchestrate increasingly violent attacks to outshine the other(s) (8, 9). The underlying assumption is that greater violence shows greater commitment and/or capability and can help garner support from the population. This mechanism was first proposed in Bloom, 2004 to explain escalating suicide bombings in Palestine by Hamas and Fatah, vying to be championed by the citizenry. The First and Second Intifadas are sometimes cited as examples of this practice. Similar phenomena have been described in scenarios that include nationalist, left and right-wing political violence (10), or within ethnic conflicts (11). At times, caveats have been included such that outbidding will emerge only if communities are supportive of suicide bombings, or if religiously or nationalistically motivated (12). Other authors have questioned the principle of outbidding leading to escalation of suicide terrorism and, in general, of terrorist acts of any type. For example worldwide data from 1970

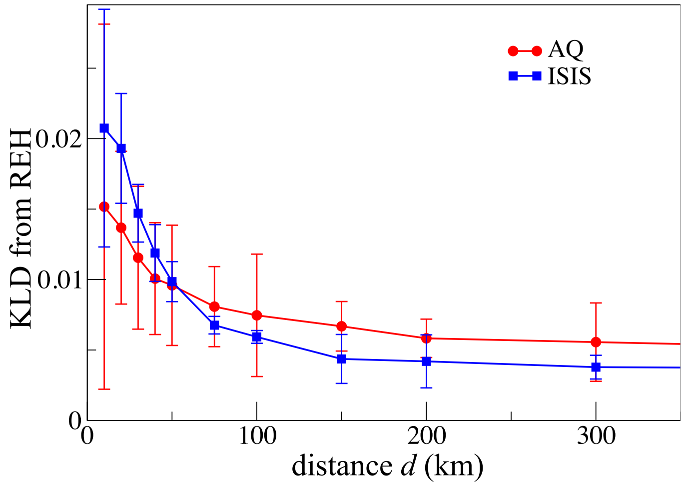

Fig. S6. The Kullback-Leibler divergence (KLD) as function of the distance threshold d for AQ and ISIS post-2014. The KLD measures the deviation of observed near-repeat latent time distributions from the random-event hypothesis (REH). Near-repeat latent time distributions are constructed for pairs of AQ→AQ and ISIS→ISIS attacks separated by a geographical distance limited by the upper threshold d. Ten periods of $4w = 176$ weeks with different start dates are sampled over the 204 weeks between Feb 2, 2014 and Dec 31, 2017. Resulting averages and error bars are shown for various values of d. The curves indicate that a distance threshold of $d = 20$km provides the most distinguishable ranges of KLD values from those with thresholds larger than 100km. Overall the KLD decreases for both AQ and ISIS as d increases. At short distances, ISIS exhibits larger deviation from the REH than AQ, revealing relatively stronger near-repeat tendencies. At long distances, however, the ISIS data deviates from the REH less than the AQ data, suggesting possible long-distance coordination of AQ activities through its global network.

to 2004 was analyzed in (13). Apart from Israel, little support is found for outbidding, leading the authors to warn of the dangers of overgeneralizing from a limited set of cases. Others yet have criticized describing even the conflict in Palestine as an outbidding process and have excluded it from occurring in Iraq, at least prior to the advent of ISIS (14, 15). A frequent objection to outbidding as a way to bolster support from the local population is that if this were the case, there would be fewer attacks with unknown offenders as terror groups would better advertise their actions. For the GTD data we analyzed about 46% of the total number of relevant attacks was due to unknown perpetrators. We examined the possibility of competitive escalation between the major terrorist groups in each cluster where applicable. In particular we consider the Iraq and Syria clusters, where the major players are ISIS and the L class. Instead of filtering for the number of suicide attacks, we analyze near-reaction patterns filtering for the number of casualties, as data is more plentiful.

The first scenario considered, shown in Fig. S7 is that of general outbidding, where any type of attack is followed by a lethal attack from rival groups with *at least* one, two or three casualties. These panels are denoted as L $\rightarrow$ ISIS$^+$ (ISIS $\rightarrow$ L $^+$) where the presence of casualties is represented by the + sign. For comparison we also replot the L $\rightarrow$ ISIS (ISIS $\rightarrow$ L) panels from the main text. As can be seen, the duration of the near-reaction time window, and the general shape of the attack pair distribution does not change much when lethality is taken into account compared to when it is. The only trend that arises is the same observed in the L $\rightarrow$ ISIS (ISIS $\rightarrow$ L) panels: the more nimble L class will more swiftly respond to ISIS attacks, to generate more support or attention, while ISIS will delay its response. The same findings are found in the Syria shown in the right hand side of Figure S7. Another possibility is that of an incremental outbidding scenario, where a lethal attack with X casualties is followed by another with at least Y > X casualties (L$^+$ $\rightarrow$ ISIS^{++}). Various choices for X,Y are shown in Fig. S8; however just as above no novel trend can be identified compared to the L $\rightarrow$ ISIS (ISIS $\rightarrow$ L) panels. We also considered mutually lethal outbidding, where any deadly attack is followed by any other deadly attack, L$^+$ $\rightarrow$ ISIS $^+$. Finally, for Iraq we could also strictly select for suicide attacks, whereas this not possible in Syria due to insufficient data. No novel patterns were found in any of these cases. The same outcome emerged from pairing major and minor players in all other clusters.

Finally, we examined provoked outbidding where (B $\rightarrow$ A)$\rightarrow$ B attack sequences are compared to general A $\rightarrow$ B sequences. In the (B $\rightarrow$ A) $\rightarrow$ B chain of events, B strikes first and the A response is constrained to be within 20km and 4 weeks, defining a first near-reaction response. We then take this subset of A attacks, which can be thought of as provoked by B, and study how the B class responds to them, defining a second near-reaction response. Our goal is to determine whether the second B near-reaction response in the (B $\rightarrow$ A) $\rightarrow$ B sequence differs from the general B response in the unprovoked A $\rightarrow$ B sequence. Indeed, if outbidding were at play, we would expect escalation to be manifest in B's response to provoked A attacks, (B $\rightarrow$ A)$\rightarrow$ B, through larger deviations from the REH than B's response to general, unprovoked A attacks, A$\rightarrow$ B.

Only the Iraq cluster contains sufficient data for a meaningful analysis. Among the 4575 post-2014 ISIS attacks here, 105 were provoked by L according to the criteria defined above; among the 996 L attacks, 151 were provoked by ISIS. Conversely, among the 4575 post-2014 ISIS attacks in Iraq, 1330 were provoked by G; among the 2219 G interventions, 1728 were provoked by ISIS. The above ISIS/G data shows considerable interplay between terrorist activity and the Iraqi government. Provoked near-reaction panels in the Iraq cluster are shown in Fig. S9: we find no evidence of provoked outbidding either between L and ISIS, nor between G and ISIS. The panel for (ISIS $\rightarrow$L) $\rightarrow$ISIS shows in fact slightly suppressed near-reaction compared to the general L $\rightarrow$ISIS case displayed in Fig. S7; similar trends are observed for the (L $\rightarrow$ISIS) $\rightarrow$L case. We also investigated provoked outbidding involving the Iraqi government and ISIS. The (ISIS $\rightarrow$ G) $\rightarrow$ ISIS panels show elevated near reaction

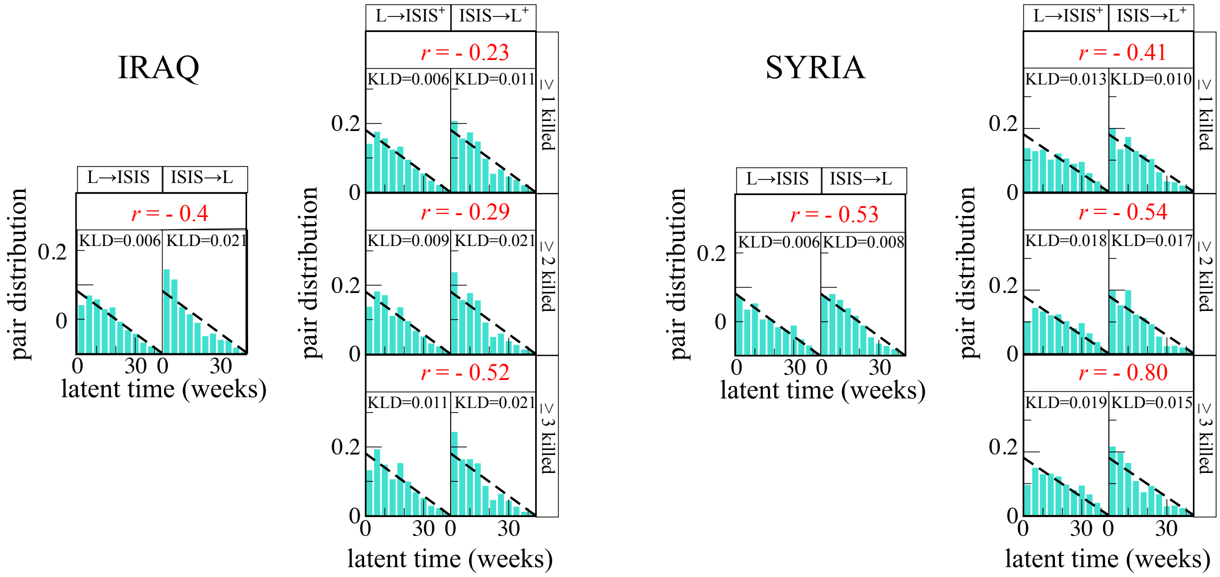

Fig. S7. IRAQ (left): Near-reaction panels L$\to$ ISIS (ISIS $\to$ L) for attacks within 20km of each other; IRAQ (right): Near-reaction panels L $\to$ ISIS$^+$ (ISIS $\to$ L$^+$) with at least one, two or three casualties in the response attack. Note the L$\to$ ISIS$^+$ (ISIS $\to$ L$^+$) and the L$\to$ ISIS (ISIS $\to$ L) panels carry similar features: no essential changes can be detected. The nimble L class responds quickly to ISIS attacks, whereas ISIS will require longer decisional and/or organizational time to respond, regardless of lethality. The same trends are seen in the Syria panels. Incremental outbidding, mutually lethal outbidding, or (in the case of Iraq) suicide attack near-repeat reveal no sign of outbidding.

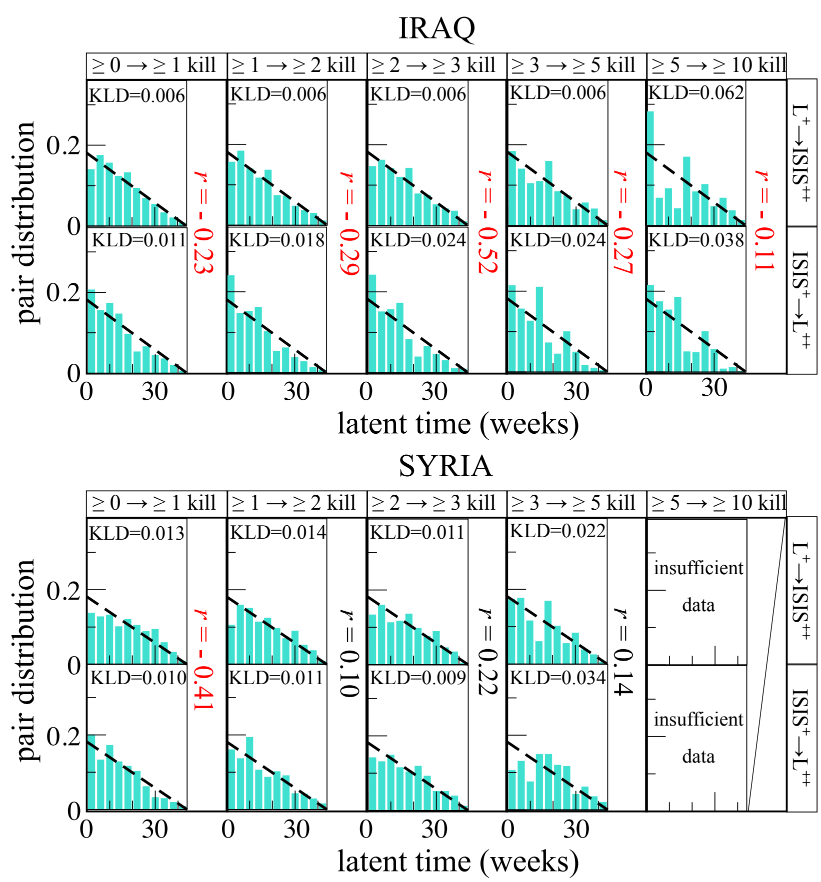

Fig. S8. Iraq (left): Near-reaction panels L$^+$ $\to$ ISIS^{++} and ISIS$^+$ $\to$ L^{++}, where deadly attacks trigger deadlier attacks within 20km of each other. Stratifying on the basis of the number of casualties does not yield any novel trend, apart from the already noted ISIS/L response asymmetry as they react to each other's attacks. The same inconclusive trends are seen in the Syria panels.

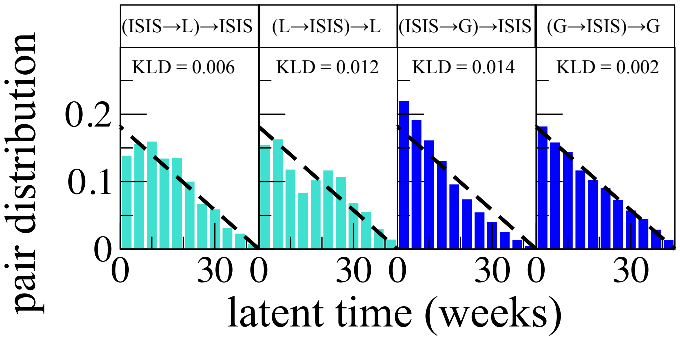

Fig. S9. Provoked attack near-reaction panels in Iraq. ISIS responses are not enhanced when responding to provoked attacks by the L class, compared to when responding to general, unprovoked L class events. This can be seen by contrasting the (ISIS →L) →ISIS panel here with the L → ISIS one in Fig. S7. Similarly no provoked outbidding is observed for L responding to ISIS if one compares the (L →ISIS) →L panel here with the ISIS → L one in Fig. S7. No provoked outbidding is seen either between ISIS and the Iraqi government forces, which is evident by comparing the (ISIS → G) → ISIS panel here with the G → ISIS one in Fig.4(c1) of the main text or by comparing the (G → ISIS) → G panel here with the ISIS → G panel in Fig.4(c1) of the main text.

as ISIS responds to provoked government operations, however the response is not noticeably different or stronger than ISIS responding to general G events, as can be seen in the G → ISIS panel Fig. 4(c1) of the main text. Both show elevated ISIS response likelihood within the first 4 months and the same degree of deviation from REH (KLD=0.014 in both provoked and unprovoked government operations). No outbidding is observed in the (G → ISIS) → G events either: G responds to ISIS retaliations indifferently, indicated by the near-REH latent time distribution. The same analysis is not possible for Syria due to lack of sufficient data.

Our work thus can be placed within the literature warning of the application of outbidding as a general theory: near-response and near-repeat trends do not seem to greatly change when escalation is included. Perhaps, apart from specific cases such as Palestine and its unique Hamas-Fatah rivalry, terrorist groups operate in the same way whether or not attacks involve casualties; whether casualties arise may also be largely out of their control. This is also confirmed by recent studies which explicitly exclude competitive escalation between AQ and ISIS (16).

Government intervention

The interplay between counterterrorism efforts and terrorist attacks (17) is studied in the Iraq, Somalia and Afghan-Pakistan clusters, since they are the only ones where sufficient data is available. As mentioned in the main text, we utilize the Uppsala Conflict Data Program (UCDP) dyadic dataset (18) to do this. The data is collected from global media sources and listed in terms of dyads engaged in armed conflict; players may include state actors. A dyad is considered to be in conflict if both sides adopt incompatible positions that lead to more than 25 casualties within a year, in which case all related activities are recorded. We cross-list this data with terrorist events from the GTD to create near-reaction diagrams. In Iraq, between 2014-2017 the UCDP lists 2230 incidents involving the Iraqi government directed at ISIS; the GTD lists 4362 attacks for ISIS and 996 L-class events in the same time interval. For Somalia, we study the effects of counterterrorism activity between Feb 9, 2012, the day that al-Shabaab officially joined the AQ, and Dec 31, 2017. Coincidentally, the Federal Government of Somalia was established on August 20, 2012. The UCDP lists 1847 events by the Somali government against al-Shabaab while the GTD lists 2850 al-Shabaab attacks within the same timeframe. The Taliban government was overthrown from Afghanistan in 2001, following the US-led invasion that took place after the 9/11 attacks. For the Afghan-Pakistan cluster thus a natural timeframe for terrorist and counterterrorist near-reaction studies would be the post-2001 period. Note that the 2014 AQ/ISIS rift is unlikely to play a relevant role here since the Taliban were never officially part of either AQ or ISIS. Before 2003 however, the UCDP logs only one incident, whereas the GTD contains only 8 Taliban attacks. This is most likely due to the relatively quiet period following the Taliban's defeat: immediately after their 2001 capitulation it underwent an internal reorganization and launched its first insurgency against the Afghan government in 2003. We thus conduct our analysis of the Afghan-Pakistan cluster within the Jan 1, 2003 – Dec 31, 2017 time interval. Here, the GTD lists 9406 Taliban attacks and 394 ISIS attacks between 2003-2017; the UCDP lists 21030 instances of anti-terrorist intervention. Data for Syria is not available, as the UCDP only recently began translating its polygon dyad system into geographic coordinates; data for Nigeria is not sufficient for a meaningful analysis. Due to the volatile and complex civil war in Yemen, there are severe ambiguities in identifying the legitimate government. Our finding of enhanced near-reaction activity between government and terrorist activity, with long term deviations from the REH in all clusters for which data was available, suggests that state-sponsored military actions may yield increased levels of violence, at least in their immediate aftermath. Although we consider domestic state actors as compiled by the UCDP (the Iraqi, Somali and Afghan governments) our findings are consistent with a recent study on foreign military intervention conducted in 122 countries between 1970 and 2015 where foreign counterterrorism action was similarly associated to a short-term increase in terror incidents (19).

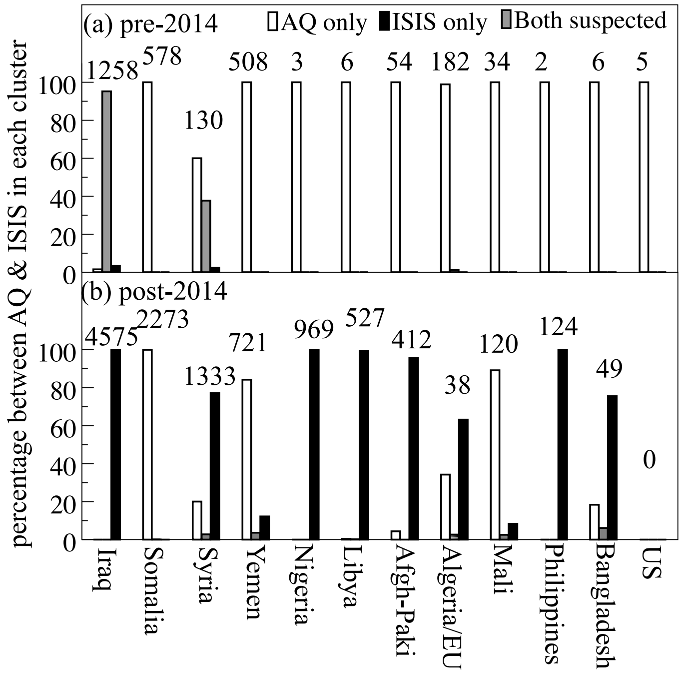

Fig. S10. Percentages of attacks by AQ and ISIS, including their respective affiliates, in each of the twelve clusters. Panel (a) shows pre-2014 data, when ISIS was mostly confined to Iraq and Syria as an AQ affiliate. Panel (b) shows post-2014 data, after ISIS began spreading to other regions independently from AQ. Post-2014, AQ's activities concentrate in Somalia, Yemen, Mali; in all other clusters where activities are reported ISIS is the most active. The total number of AQ and ISIS attacks per cluster and period is labeled above the bar graphs. Total numbers increased from pre-2014 to post-2014 in Iraq, Somalia, Syria, Yemen, Afghan-Pakistan, and Mali; the Nigeria, Libya, Philippines, and Bangladesh clusters went from nearly no attacks to tens or hundreds of attacks. Conversely, post-2014 attacks in the Algeria/E.U. cluster decreased; there have been no been direct AQ/ISIS attacks in the U.S. post-2014.

Pre-2014 data

In Fig. 3(a) of the main text, we show how attacks are distributed between AQ and ISIS in each cluster during the time period 2001-2017. Figs. S10(a) and (b) compare these percentages before and after the 2014 AQ/ISIS rift. Since ISIS was largely confined to Iraq and Syria at the time, the pre-2014 attacks in all other clusters are almost exclusively due to AQ as shown in Fig. S10(a), except for a very small fraction (1%) in the Algeria/E.U. cluster. In Iraq, 95% of pre-2014 attacks were perpetrated by ISIS and its various predecessors as part of AQ's global network, 3% were by the ISIS predecessor JTJ, which was never officially an AQ affiliate, and 2% by other small AQ cells in the region. In Syria, 60% of attacks were perpetrated by AQ-affiliated JN; ISIS as an affiliate of AQ was responsible for 38% of attacks, mostly occurring during 2013 when it began expanding into Syria. The remaining 2% were earlier 2002 attacks in Jordan by JTJ. After the AQ/ISIS 2014 rift ISIS overtook AQ as the most attack-prolific terrorist group in most clusters, including Iraq, Syria, Nigeria, Libya, Afghan-Pakistan, Algeria/E.U., the Philippines, and Bangladesh, as shown in Fig. S10(b). Post-2014 AQ maintained its dominance only in Somalia, Yemen, and Mali.

Figs. S11(a) and (b) show the pre-2014 near-repeat and near-reaction latent time distributions for AQ, ISIS, and L class attacks separated by less than 20km in the Iraq, Somalia, and Syria clusters. The others do not contain sufficient pre-2014 data for a significant analysis. For example, the Yemen and Algeria/E.U. clusters display numerous attacks that were sparsely distributed over large areas, leading to few near-repeat/reaction pairs of events. In contrast, the pre-2014 attacks in Syria mostly concentrated within two years (2012-2013) over the relatively smaller area of northern and eastern Syria. Fig. S11(a) shows that the minor classes, defined as those with fewer number of combatants, exhibit more prominent near-repeat tendencies than major ones, in agreement with results shown in Fig. 4 of the main text. Fig. S11(b) reveals asymmetric near-reaction patterns for rival groups so that local militias/insurgent groups from the L class respond promptly to AQ/ISIS attacks, whereas the latter show delayed reactions. This is also consistent with results shown in Fig. 5 in the main text. In pre-2014 Iraq, 95% of AQ/ISIS attacks were attributed to both since ISIS was considered an AQ affiliate from 2004 to 2014. As a result, the AQ$\to$AQ and ISIS$\to$ISIS near-repeat patterns in Fig. S11(a) are almost identical, with KLD $= 0.023$ and 0.020 respectively. AQ and ISIS also both show slightly elevated near-repeat likelihood within the first eight weeks of an initial attack compared to the REH; in contrast, the L class shows a much higher near-repeat probability within the first eight weeks after an initial attack, if compared to both AQ and ISIS, with KLD $= 0.18$. Most L class attacks in pre-2014 Iraq were attributed to small groups that executed less than five attacks, in addition to non-specific perpetrators, such as Sunni/Shia/Muslim extremists, pro-government/Baathist extremists, tribesmen, and separatists. The numerous small terrorist groups most likely reflect the changing sociopolitical Iraqi scenario, as the initial insurgency against the U.S.–led coalition became an insurgency against the Shia Muslim–led Iraqi government. The large number of non-specific perpetrators may be due to limited coverage from the Western press, and possibly because the turbulent and rapidly changing terrorism landscape was largely unstructured or

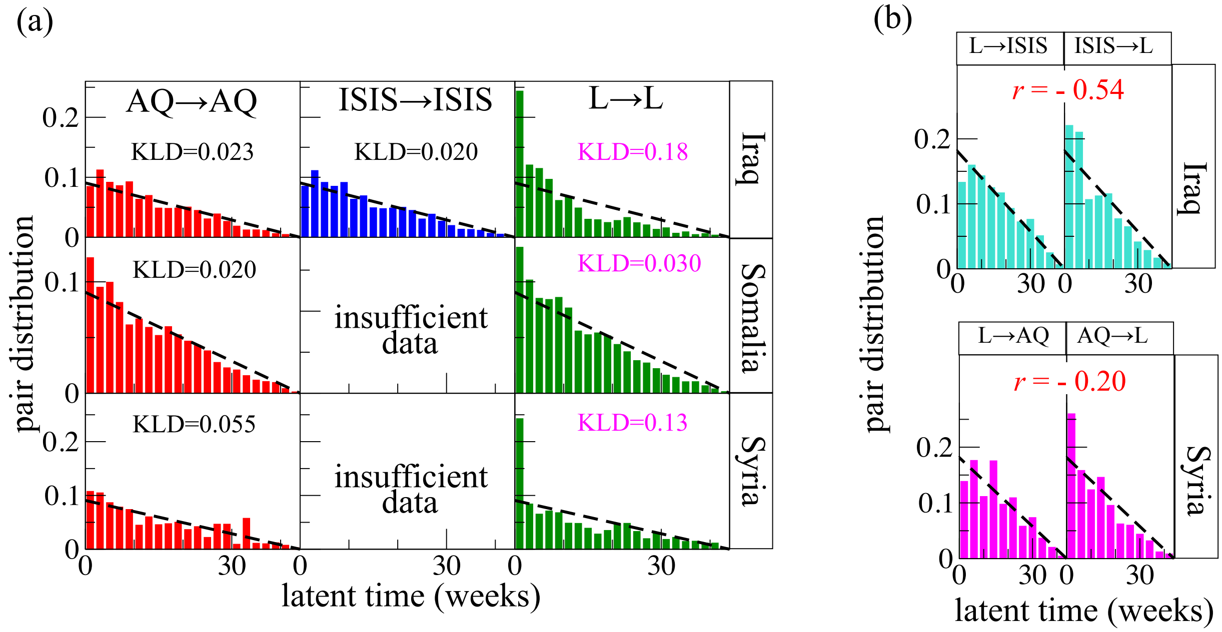

Fig. S11. (a) Pre-2014 near-repeat patterns of AQ, ISIS, and L classes in Iraq, Somalia, and Syria. In Iraq and Syria AQ/ISIS were major players compared to the local L class. In Somalia the AQ→AQ panel refers to al-Shabaab post-2012 (and pre-2014) after it officially joined AQ, while the L→L panel refers to al-Shabaab pre-2012, while it still operated as an independent group. The KLD quantifying the deviation of the observed near-repeat data from the REH is evaluated for each panel; the largest per cluster is highlighted in magenta. Note that the L class exhibits the greatest deviation from the REH in both Iraq and Syria, consistent with the hypothesis that minor players manifest larger near-repeat likelihoods compared to major ones. No such distinction is possible in Somalia since the only group operating here is al-Shabaab, either as an AQ affiliate or as an independent entity. (b) Pre-2014 near-reaction patterns ISIS→L and L→ISIS in Iraq and AQ→L and L→AQ in Syria. Both cases result in asymmetric latent time distributions and negative r between AQ/ISIS→L and L→AQ/ISIS. The negative correlation between ISIS and L in Iraq is moderately significant, and is consistent with the hypothesis of adversary relations between the two classes. The correlation between AQ and L in Syria is weak.

unknown to the outside world during this period. A case in point is the especially volatile year 2006. L class groups associated with more than 10 attacks pre-2014 include known ISIS allies such as Ansar al-Islam and Ansar al-Sunna, as well as ISIS opponents, such as PKK, the Peace Companies (also known as the Mahdi Army), and Asa'ib Ahl al-Haqq. The great number of small groups and non-specific perpetrators raises uncertainties as to whether the pre-2014 L class in Iraq acted as an ally or an opponent of ISIS, or even as to whether it can be considered a unique block. The general understanding however is that local insurgents mainly expressed anti-ISIS sentiment, as ISIS's ideological intolerance often exacerbated sectarian conflicts. ISIS experienced hostility even within its own Sunni-Muslim community, as exemplified by the Anbar Awakening movement between 2005 and 2008, when local Sunni militias and tribes rose against ISIS in northern Iraq. This conjecture is corroborated by the asymmetric near-reaction patterns between ISIS and local L class groups in Fig. S11(b), with a moderately significant negative correlation $r = -0.54$. This implies that L class groups responded promptly to ISIS attacks, whereas ISIS delayed its reactions after L class attacks, which is consistent with the post-2014 analysis given in the main text. Since 95% of AQ and ISIS attacks overlapped in pre-2014 Iraq, the AQ versus L near-reaction plots are essentially identical to the ISIS versus L ones and thus not shown. Similarly, AQ→ISIS and ISIS→AQ near-reaction patterns are essentially the same as AQ→AQ and ISIS→ISIS near-repeat patterns and are also omitted.

The Somalia cluster is dominated by al-Shabaab, which was officially recognized as an AQ affiliate in 2012, whereas ISIS is not present in this region. The AQ→AQ and L→L panels shown Fig. S11(a) both refer to near-repeat patterns of al-Shabaab, but at different times. Before 2012, as an independent group al-Shabaab exhibits elevated near-repeat likelihood over a period of 12 weeks after a first attack, as shown in the L→L panel for Somalia in Fig. S11(a). This is longer than the eight-week period shown in the AQ→AQ panel in the same figure which contains al-Shabaab 2012-2014 data. Over the first eight weeks, the near-repeat probability is also slightly higher before 2012 (L→L) than after 2012 (AQ→AQ). Since the AQ and the L classes here do not overlap in time, there is no near-reaction between AQ and L.

In Syria, the majority of pre-2014 attacks took place between 2012-2013 during the Syrian Civil War. ISIS invaded Syria in April 2013, but there is not enough data to study ISIS→ ISIS near-repeat patterns. Indeed, during most of the pre-2014 era, fighters from ISIS or its precursors joined AQ-affiliated JN in opposition to other anti-government rebels, so that in Syria AQ is the major class, followed by the local L class and no significant ISIS presence is found. While both AQ-affiliate JN and L class rebels exhibit heightened near-repeat probability over the first four weeks, as shown in Fig. S11(a), the near-repeat probability is especially large during the first two weeks for the L class, leading to a KLD value of 0.13, larger than that of AQ-affiliated JN, which is 0.055. The pre-2014 L class in Syria consists of the same anti-government rebels as in the post-2014 L class discussed in the main text, including the Free Syrian Army, the PKK, and the Islamic Front. However, the 2014 AQ/ISIS rift changed the relation between AQ and these L class groups. AQ came to Syria through its affiliate JN in 2012 which emerged as an opponent to most of the local rebels. This is reflected in the asymmetric near-reaction AQ→L and L→AQ patterns shown in Fig. S11(b) marked by a weak negative correlation $r = -0.2$. The moderate negative correlation value may stem from tentative alliances between AQ and local militia groups after the ISIS invasion of Syria in April 2013 which lead to more symmetric behavior. Nonetheless, the overall weakly asymmetric near-reaction pattern confirms that the response from the local L class groups is enhanced when AQ strikes first, whereas reactions from the transnational AQ class are delayed, consistent with findings presented in the main text for post-2014 data. Finally, as discussed in the main text, AQ and local L class antigovernment rebels became allies against ISIS in post-2014 Syria, leading to symmetric near-reaction AQ→L and L→AQ patterns, marked by a positive correlation coefficient $r = 0.61$ as shown in Fig. 5 of the main text.

References

1. Lloyd S (1982) Least squares quantization in PCM. *IEEE Transactions on Information Theory* 28:129–137.
2. Karmon E (2014) Boko Haram's international reach. *Perspectives on Terrorism* 8:74–83.
3. Goldman O (2011) The globalization of terror attacks. *Terrorism and Political Violence* 23:31–59.
4. LaFree G, Morris N, Dugan L (2010) Cross-national patterns of terrorism: Comparing trajectories for total, attributed and fatal attacks, 1970–2006. *The British Journal of Criminology* 50:622–649.
5. Kilcullen D (2011) *The Accidental Guerrilla: Fighting Small Wars in the Midst of a Big One.* (Oxford University Press, Oxford, UK).
6. Bacon T, Arsenault EG (2017) Al Qaeda and the Islamic State's break: Strategic strife or lackluster leadership? *Studies in Conflict & Terrorism* 42:229–263.
7. Zelin AY (2014) *The war between ISIS and al-Qaeda for supremacy of the global jihadist movement.* (The Washington Institute for Near East Policy, Washington D.C.).
8. Bloom M (2004) Palestinian suicide bombing: Public support, market share, and outbidding. *Political Science Quarterly* 119:61–88.
9. Kydd A, Walter B (2006) The strategies of terrorism. *International Security* 31:49–80.
10. Della Porta D (2013) *Clandestine Political Violence.* (Cambridge University Press, New York, NY).
11. Horowitz DL (1985) *Ethnic groups in conflict.* (University of California Press, Berkeley, CA).
12. Nemeth S (2014) The effect of competition on terrorist group operations. *Journal of Conflict Resolution* 58:336–362.
13. Findley MG, Young JK (2012) More combatant groups, more terror? Empirical tests of an outbidding logic. *Terrorism and Political Violence* 24:706–721.
14. Brym RJ, Araj B (2008) Palestinian suicide bombing revisited: A critique of the outbidding thesis. *Political Science Quarterly* 123:485–500.
15. Ayers N (2008) Ghost martyrs in Iraq: An assessment of the applicability of rationalist models to explain suicide attacks in Iraq. *Studies in Conflict & Terrorism* 31:856–882.
16. Hamming TR (2017) Jihadi competition and political preferences. *Perspectives on Terrorism* 11:63–88.
17. Blakeley R (2007) Bringing the state back into terrorism studies. *European Political Science* 6:228–235.
18. Pettersson T, Eck K (2018) Organized violence, 1989-2017. *Journal of Peace Research* 55:535–547.
19. Danzell OE, Kisangani EF, Pickering J (2019) Aid, intervention, and terror: The impact of foreign aid and foreign military intervention on terror events and severity. *Social Science Quarterly* 100:951–964.