

Small Arms, Small Data:

Small Arms Shooting Accuracy and the Small Data Problem



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Headline Result:

Small arms shooting appears to show a “proximity effect”

- Accuracy of aim decreases as the range gets shorter
- The effect seems particularly marked below 100 metres



What kind of shooting accuracy can infantry achieve in combat?

- Sparse data – 83 data points, only 22 from combat
- Bullets per casualty reduced to common representation
 - Mils dispersion at the muzzle
 - “Reverse P(hit)” calculations
- Is there a proximity effect?
 - Candidate explanations
- Mapping to Rowland and Speight’s model of the rural infantry battle



Small Data

Many of the studies are incomplete, largely because the amount of factual information (as opposed to more or less unreliable opinion) about the chosen subject is very small. In general the amount of reliable information on almost any aspect of battle tends to be much smaller than is often supposed. It has been felt, however, that it is almost as important to be sure of what we do not, as to record what we do know. These studies illustrate how slender is the basis on which much of the theory of war depends, and emphasise the need for more knowledge in many directions. It is not enough for a modern Army to base its practice on individual opinions and traditional beliefs. It must have facts. Attempts have been made in this war, to record some of the facts of battle. These studies show that whilst such recording has been a valuable step in the right direction, it has been quite inadequate both in quality and quantity.

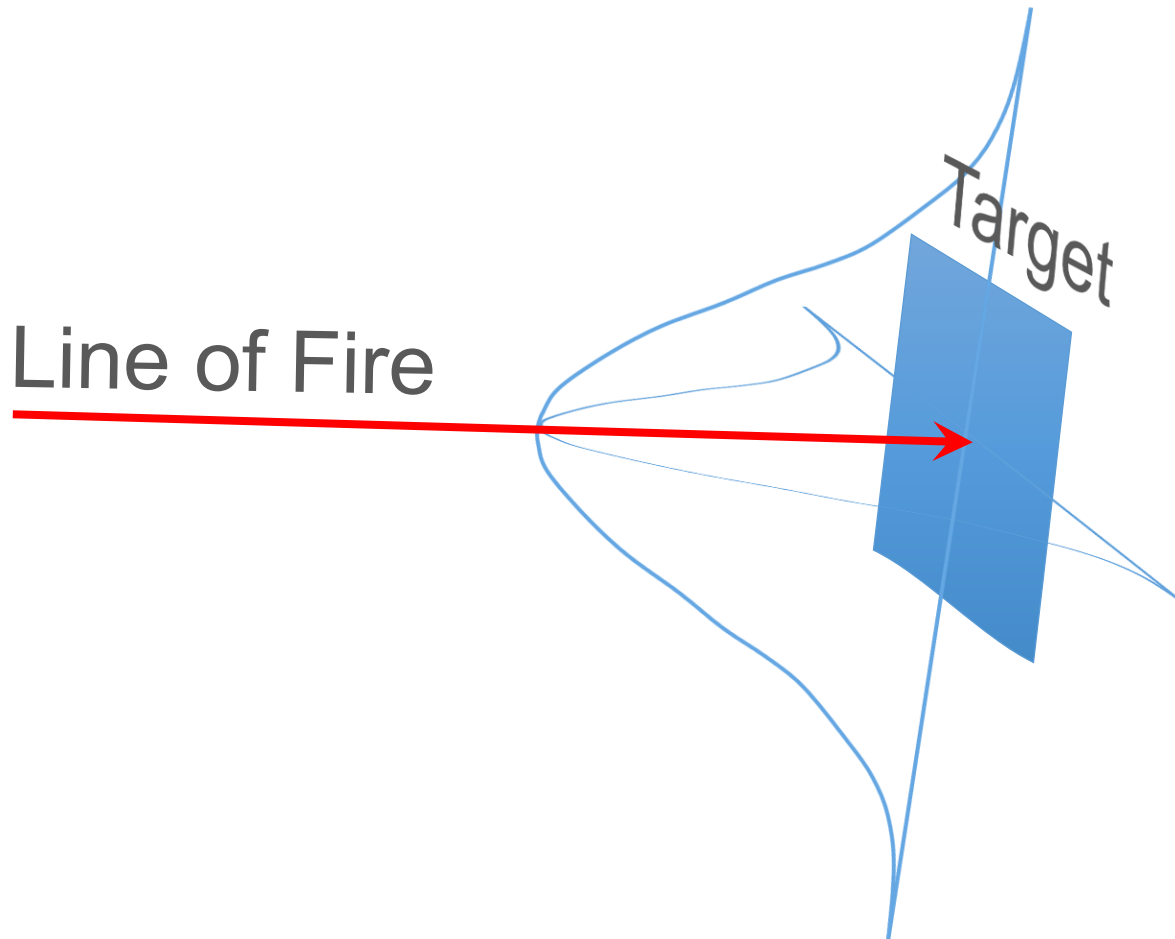
From MORU report no. 23 *Battle Study on Operation Goodwood*, Wallace and Crompton, 1946, NA piece number WO291/965



The Sources

- Combat [22 data points]
 - 1ATF actions in Viet Nam
 - Actions in Malaya 1953
 - Zuber 2010
 - Actions at Rasau, Dek Sarak, DMZ
 - Sniper programme in 9 Div, Viet Nam
- Police Shootings [8 data points]
 - NYPD and Baltimore PD
- Range Trials [35 data points]
 - 1944 School of Infantry
 - 1945 US Army Film Bulletin
 - 1954 Finnish Army
- 1962 US Platoon Firepower Experiment
- 2012 Croatian SF
- 2015 Mountain Tactical Institute
- OR models [13 data points]
 - 1944 OR model
 - 1971 RAND FAST-VAL
 - 1993 SPARTAN II
- Qualification Scores [5 data points]
 - 2008 US Army M16 shooting
 - 1961 British CQB shooting
- Panzerfausts [1 for comparison]
 - 1948 OR on WW2 experience

Dispersion of Fire





Inverse P(hit)

- OR analysts typically take an error budget and work out P(hit)
- I worked backwards
 - Take bullets per hit, and work out dispersion error
- Assumption:
 - Dispersion the same in both planes
- Target size often not stated, so assumed
 - Usually 0.5m by 0.5m (smaller than STANAG standing man)
- Reduces accuracy to a common measure, independent of range

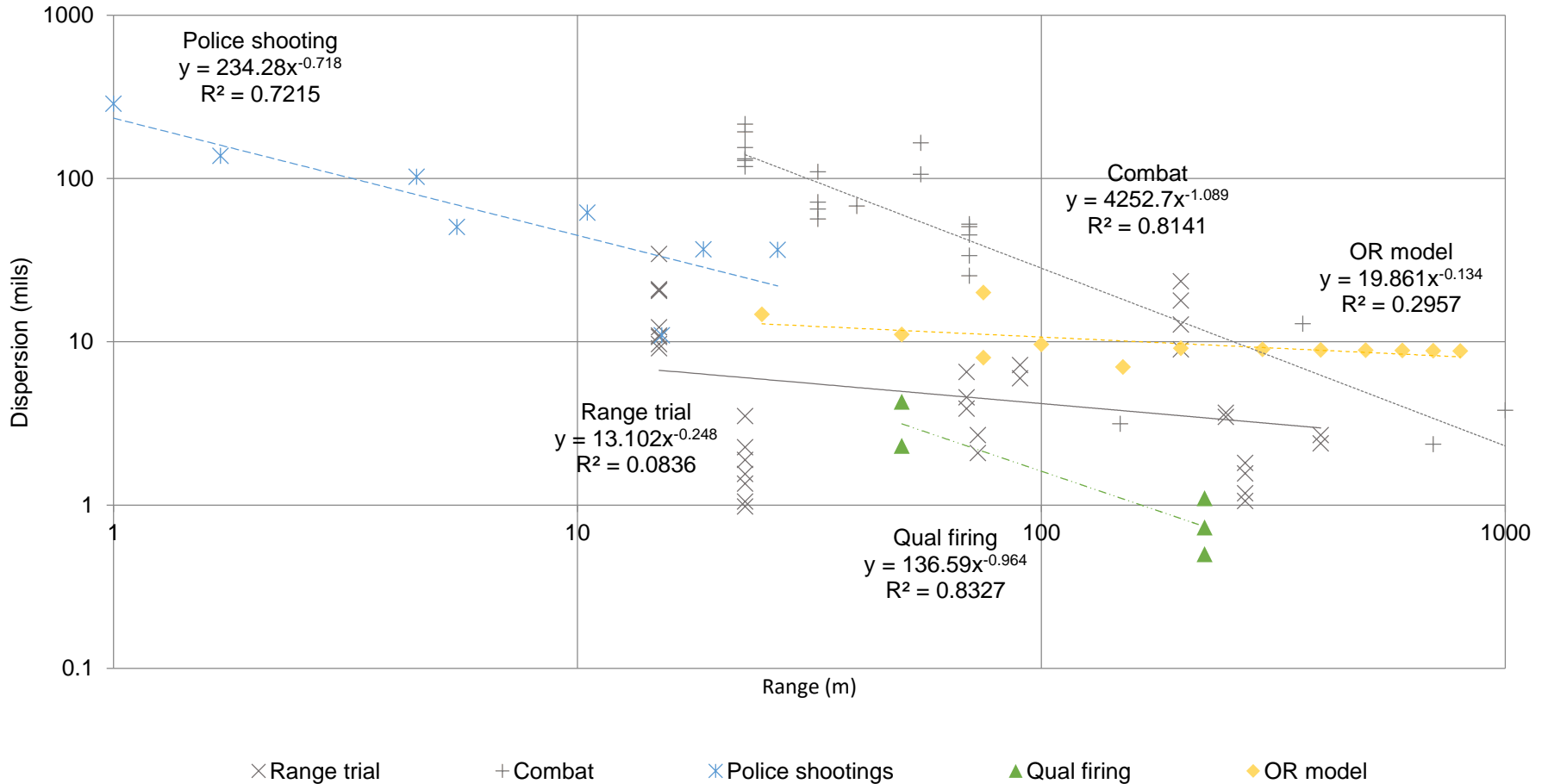


Key Data Deficiencies

- There isn't enough of it!
- Combat data:
 - Target cover and posture seldom specified
 - Day and night data not separated
 - Weight of return fire unspecified
 - Unclear what allowance made for multiple hits
 - Evacuated enemy cas not counted
- Trials data:
 - Target size often unspecified



All the Data (by source)



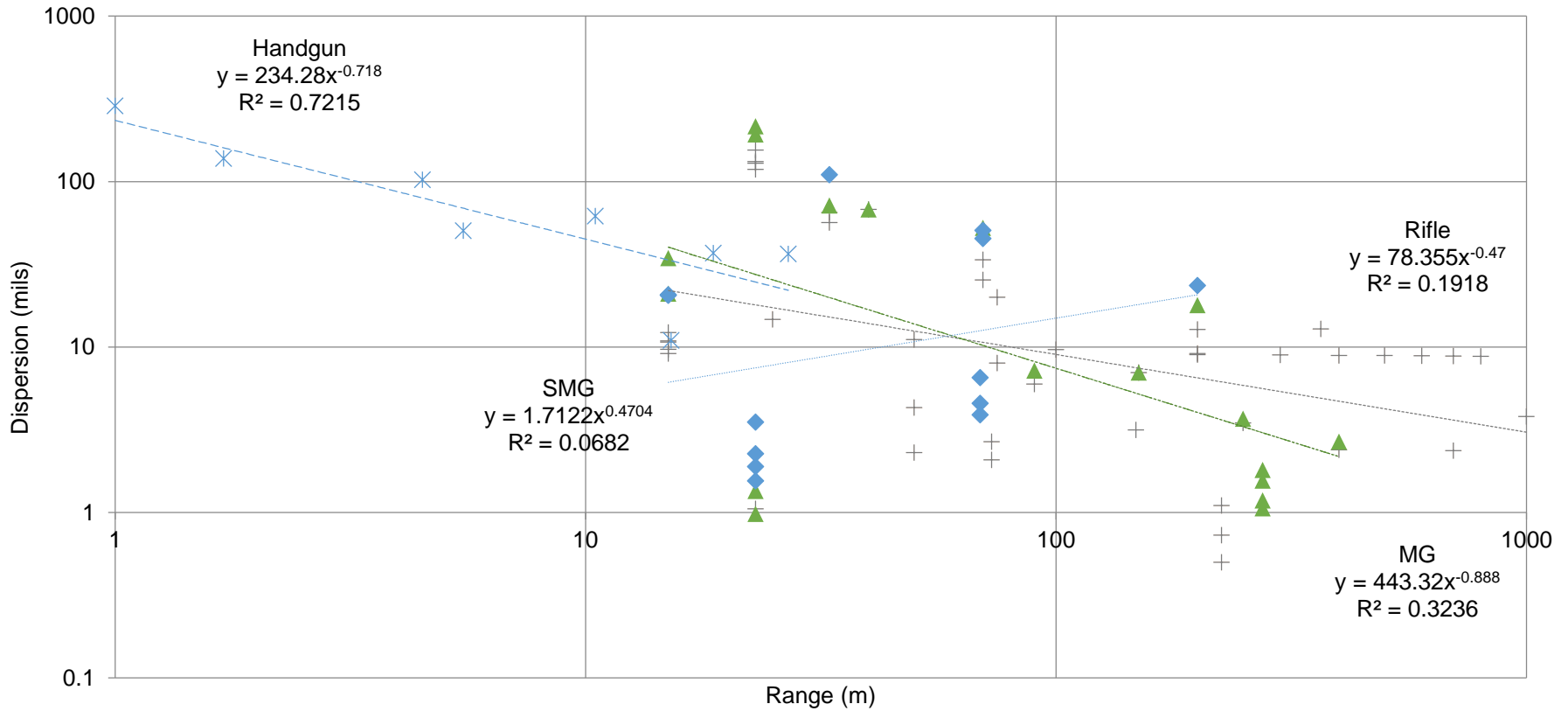


Partition by weapon type

- Rifles – 44 data points
 - Includes bolt-action, self-loading, assault rifles and carbines
 - Martini-Henry, Mauser 98, Mosin, Lee-Enfield, M1 or M2 carbine, SVT, SLR, M14, AK, AR15, M16, M4
- MGs – 18 data points
 - Includes 3 cases on tripod mounts
 - Browning M1917, Browning M1919, Lahti-Saloranta M26, leMG-34, Bren, sMG-42, M60, RPD
- SMGs – 13 data points
 - Thompson, Suomi , MP40, Sten, M3, Owen
- Pistols – 8 data points
 - All Police shooting data
 - 9mm or 10mm automatic pistol or .38 Special revolver



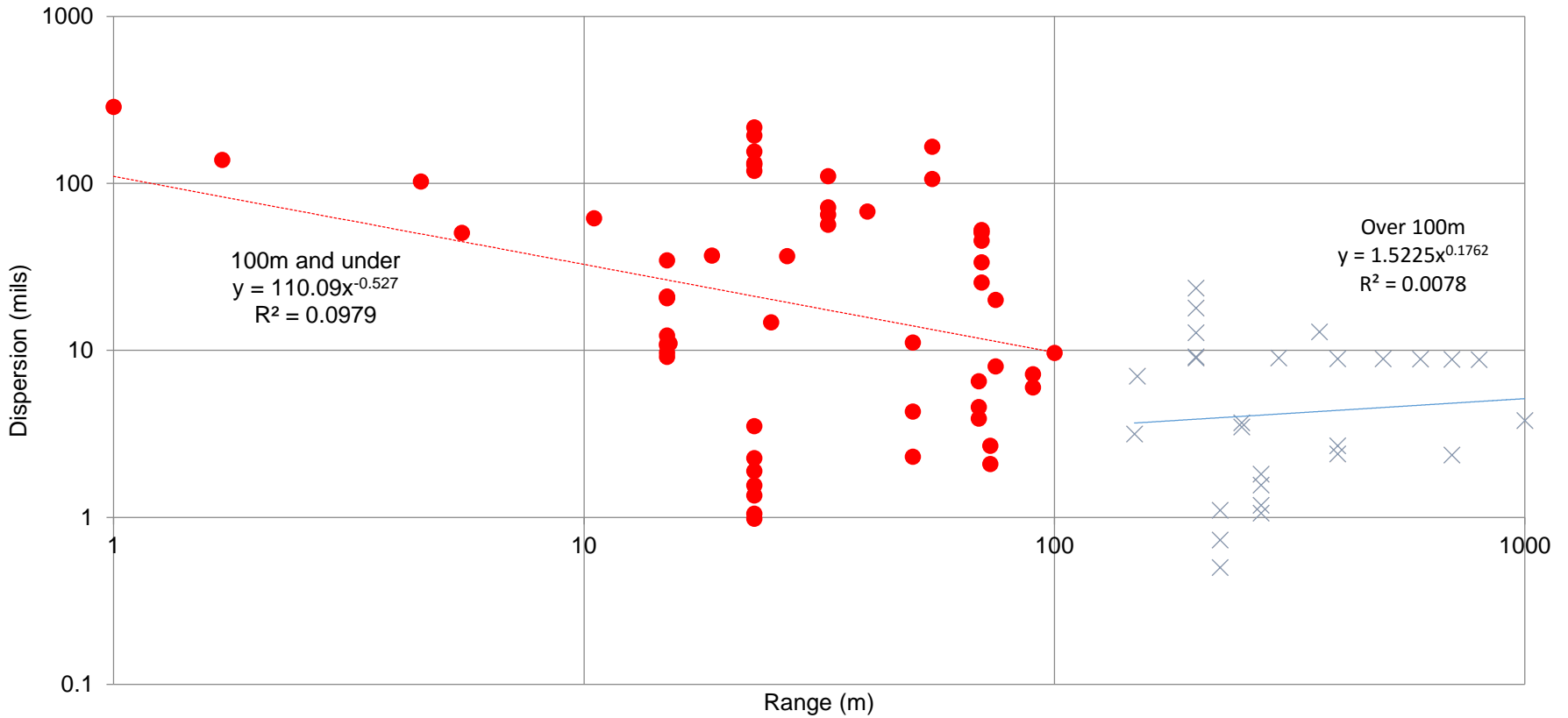
Partitioned by Weapon Type: SMGs appear perverse



+ Rifle x Handgun ▲ MG ◆ SMG



Break at 100 metres



● 100m and under × Over 100m



Action at Dek Sarak

In Afghanistan our troops, as a rule, opened an independent fire at ranges between 700 and 900 yards, as we had not then (1878-1880) any such thing as "fire discipline" in our service, and killed very few for the number of rounds fired. One notable instance was at Dek Sarak, when 28,000 rounds were expended on 50 killed at ranges under 400 yards. [...] All this firing was at the shortest ranges, [...]. In this action there was no fire discipline, control, or direction, officers were to be seen taking rifles from the men and making practice for themselves. The result was that the whole of the ammunition with the force was fired away, and the troops had to retire back to camp for want of ammunition, followed up by the enemy the whole way.

Infantry Fire Tactics, Charles Blair Mayne, 1888



Visualisation of Angles



286 mils: New York Police gunfights, 1 metre



118 mils: 1 ATF SLRs, patrol actions, 23 metres

13 mils: Dek Sarak, rifles at 366 metres

“In this action there was no fire discipline, control, or direction”

~~4.3 mils: Pass standard, SLR at 50 metres, CQB shooting~~



Candidate Explanations

1. Shooters get (relatively) worse at hitting at closer ranges through stress
2. Targets get better at limiting exposure at closer ranges
3. The combat data is mostly from close terrain (jungle)
4. The close range data is largely from restricted lighting
5. Most combat shooting is at assumed locations, not visible targets



Explanation 1: Shooter Stress

- This is the explanation offered in *Brains and Bullets*
- We know that stress and sleeplessness reduce shooting accuracy from two of the sources (Scott et al 2015, Jovanović et al 2012)
- One might assume more effective return fire from closer enemy
- Intrinsically believable from personal experience

BUT

- Some effect observable from trials (1962)



Explanation 2: Targets limit exposure at closer ranges

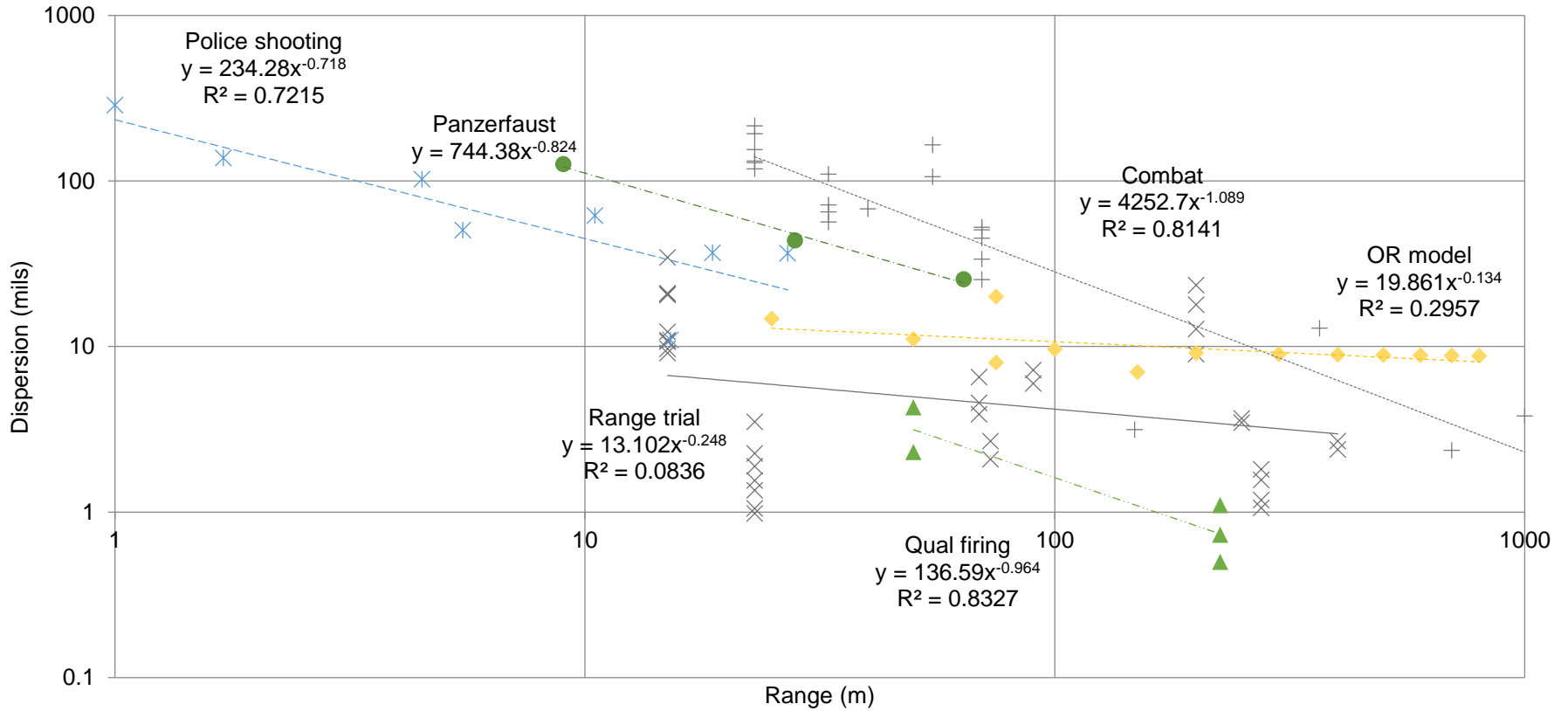
- Complies with tactical advice dating back at to Fry's *Assault Battle Drill* 1955
- “Compensating reductions” is a known psychological effect
- Angular velocity of targets moving across the line of fire is also greater at closer ranges

BUT

- Does not explain Panzerfaust shots (though angular velocity may be a factor)



Panzerfaust combat shots



× Range trial + Combat * Police shootings ▲ Qual firing ◆ OR model ● Panzerfaust



Explanation 3: Combat data is mostly from jungle terrain

- True – of 22 combat data points, 16 are from jungly terrain (Vietnam or Malaya) and at 70m or below

BUT

- Would not explain trend seen in Police shootings and Panzerfaust combat shots
- Trend still observable when jungle data points are removed



Explanation 4: Combat data is largely with restricted lighting

- True – 42% of 1ATF ambushes, 59% of Baltimore PD and 77% of NYPD shootings

BUT

- Would not explain trend seen in Panzerfaust combat shots



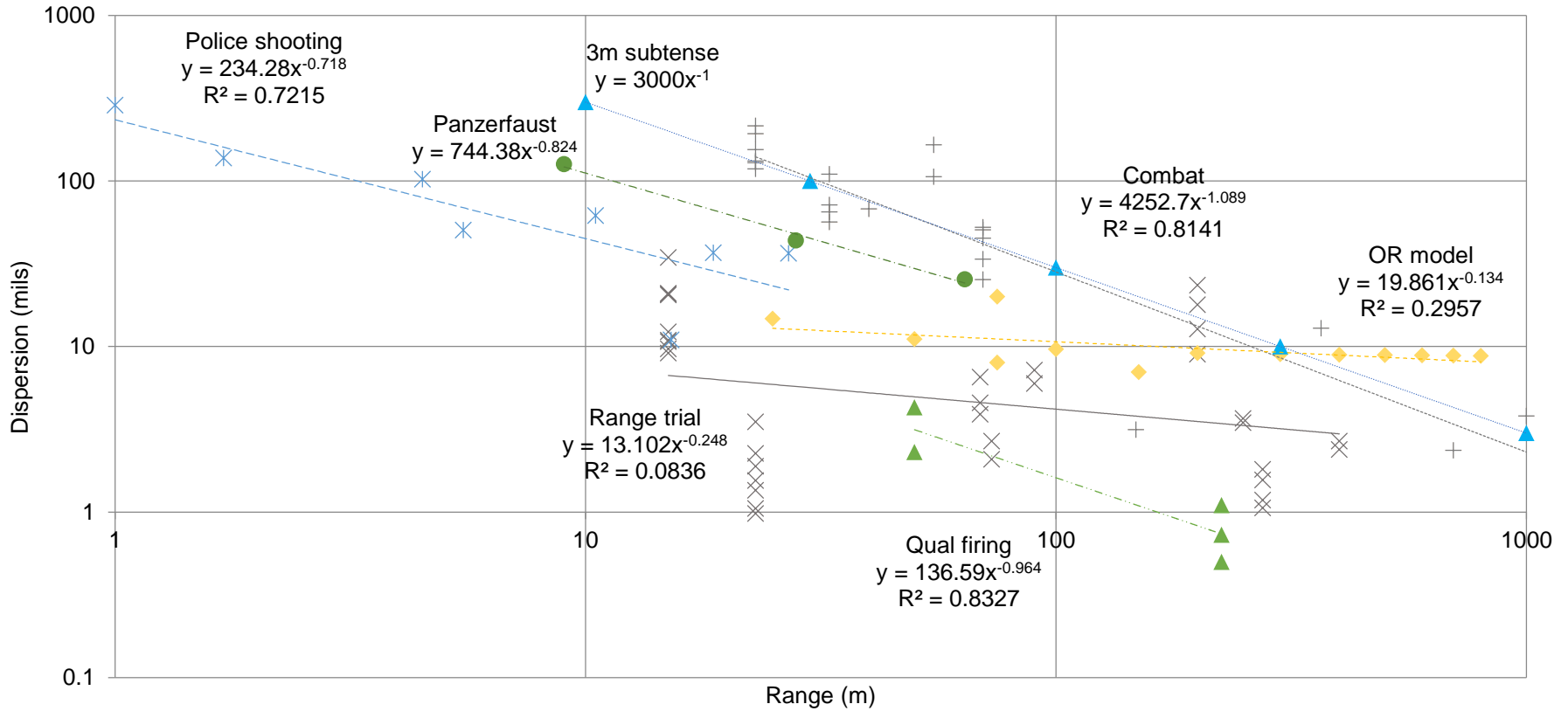
Explanation 5: Most combat shooting is at presumed locations

- True for 1ATF (see Hall & Ross 2009)
- Subtense of 3m gives remarkable agreement with combat trend

BUT

- Not true for Police shootings
- Not true for Panzerfaust combat shots

3m subtense



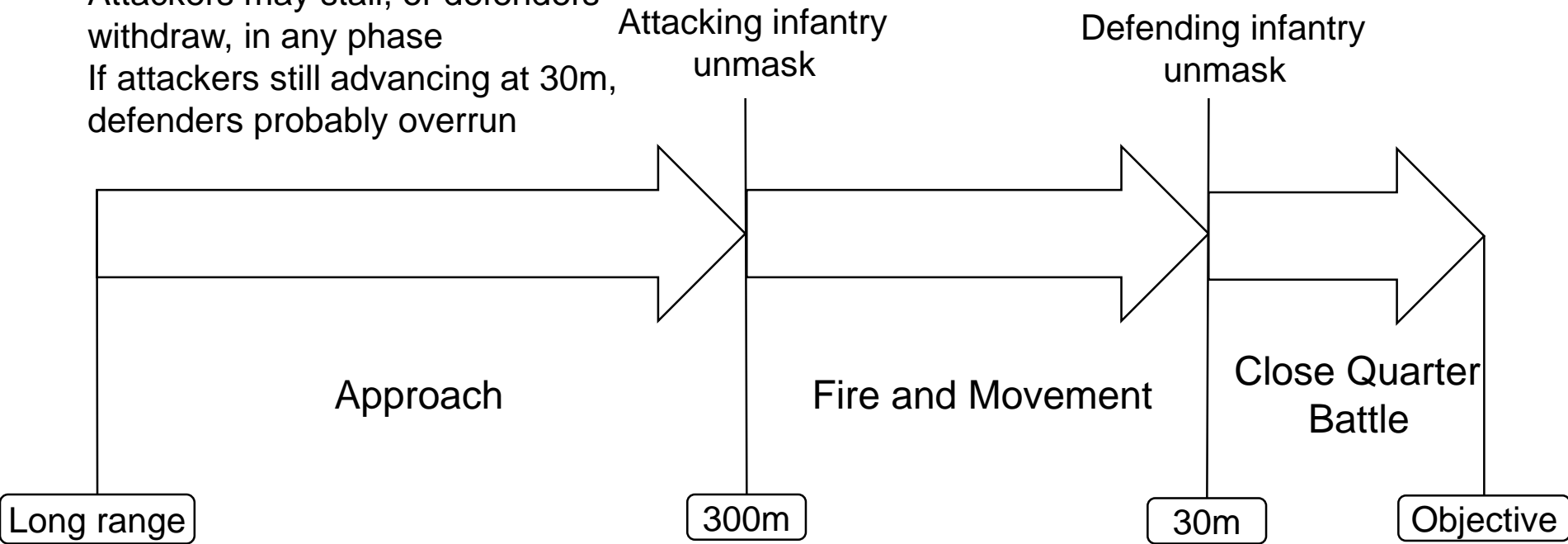
× Range trial + Combat * Police shootings ▲ Qual firing ◆ OR model ● Panzerfaust ▲ 3m subtense



Pattern of the Rural Infantry Battle

After L R Speight and D Rowland, *Modelling The Rural Infantry Battle: Overall Structure and a Basic Representation of the Approach Battle*, Military Operations Research 11(1):5-26, November 2006

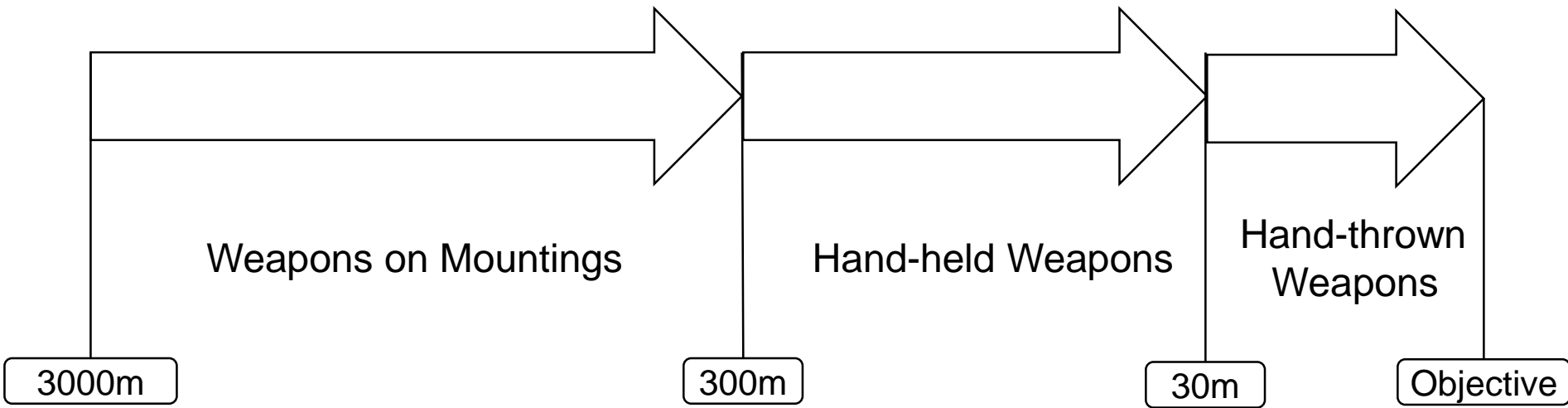
Attackers may stall, or defenders withdraw, in any phase
If attackers still advancing at 30m, defenders probably overrun





Pattern of Ranged Fire Effect

Area Fire	Aimed Fire	Instinctive shooting
Light Weapons	Small Arms	





Instinctive Shooting

- Stavers, Infantry Journal December 1944:

The function of snap shooting is clear. It is intended for short range (twenty yards and under) combat firing where troops are moving quickly toward each other. In such situations it has been observed that almost every man's instinctive reaction is to fire quickly, without stopping to bring the weapon to his shoulder.

- Note that not all definitions of “snap shooting” preclude shouldering
- Trading speed for accuracy is a rational decision
- Notice the slope of the trend between US qualification for aimed fire and UK qualification for CQB shooting



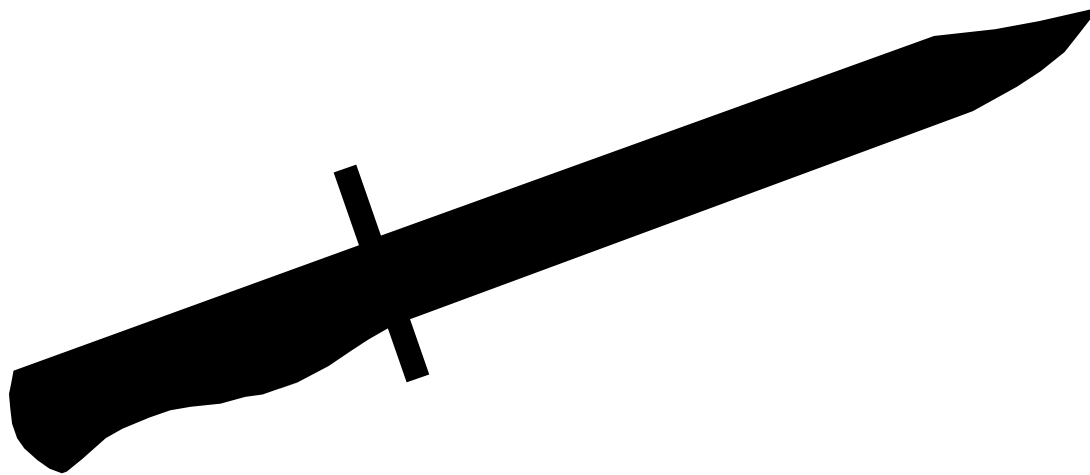
Conclusions

- Dave Rowland is right
 - Shooting in combat is hugely less accurate than range firing
- The data indicates that a proximity effect exists
 - For all source types
 - For all fire types
 - For all terrain types
 - For all weapon types except that SMGs are anomalous
 - Most noticeably below 100 metres
- Of the candidate explanations, all have some merit
 - only “increased shooter stress” has no solid objections to it
- Hasty instinctive shooting may be a rational trade of speed for accuracy
 - Even more so when suppressive effect of misses accounted for
 - This could be investigated through a simulation study
- The truth is probably some combination of all explanations
- Simunition-based experiments might add usefully to the data



Parting Shots

- We need lots more data!
- 100m is very close to Rowland's range for the onset of infantry shock





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Questions?

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