The Influence of Peer Reviewer Expertise on the Evaluation of Research Funding Applications

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Studying Reviewer Decision-Making

- *"NIH peer review percentile scores are poorly predictive of grant productivity" Fang et al., 2016*

- Decision-making processes understudied

- What drives reviewers' evaluations?

Reviewer Decision-Making Model

- Boudreau (2016) study used ***blinded***, individual reviews of grant applications
- Found shorter intellectual distance (***keyword based***) between applicant and reviewer leads to harsher evaluations

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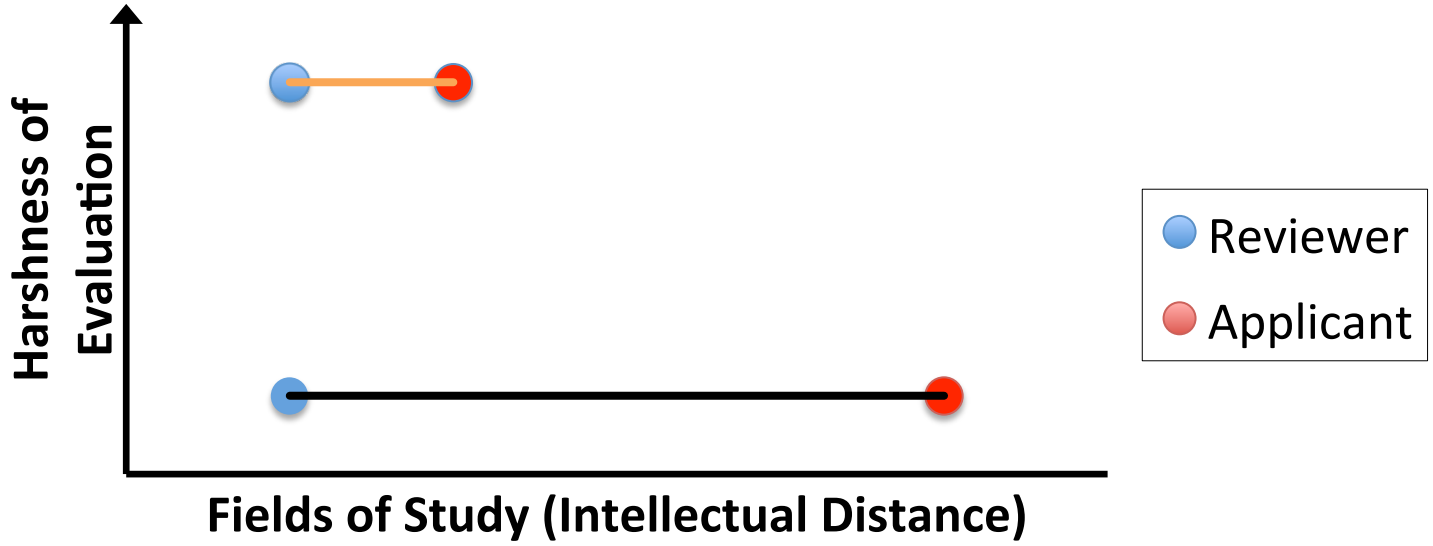
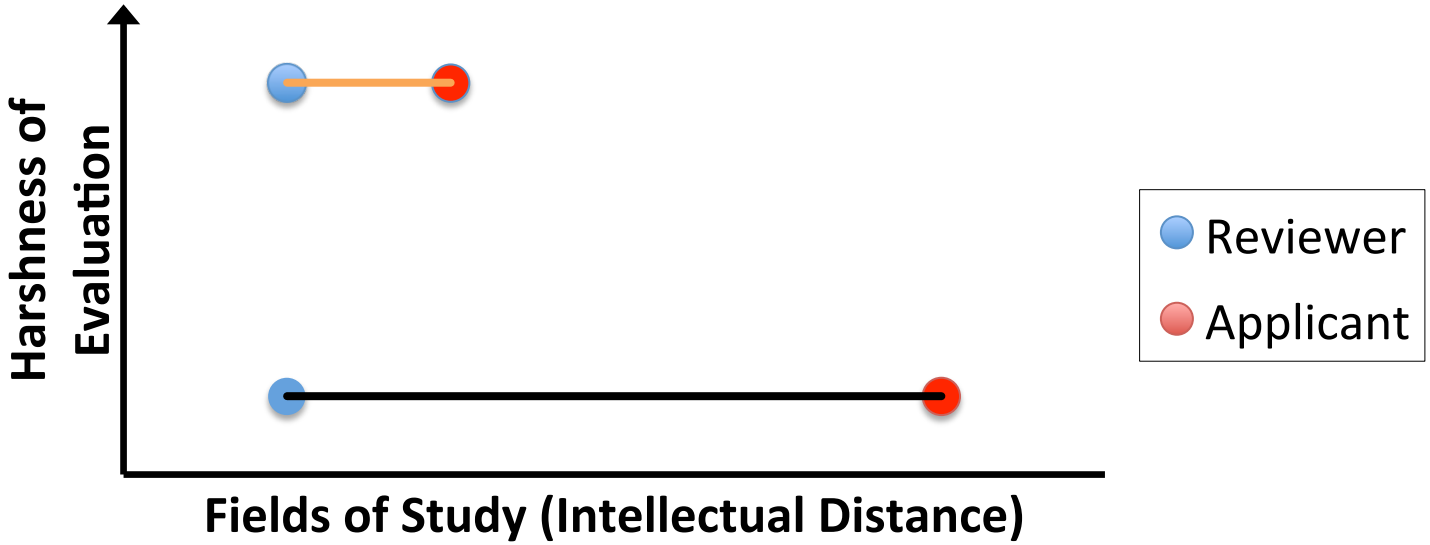


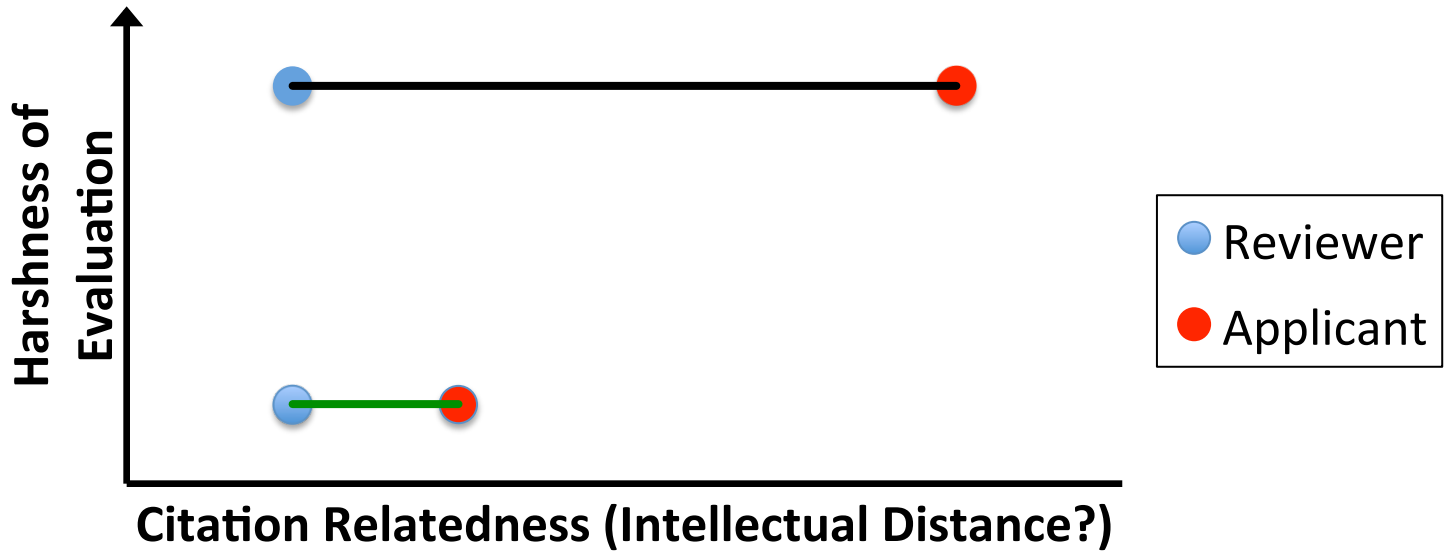
Reviewer Decision-Making Model



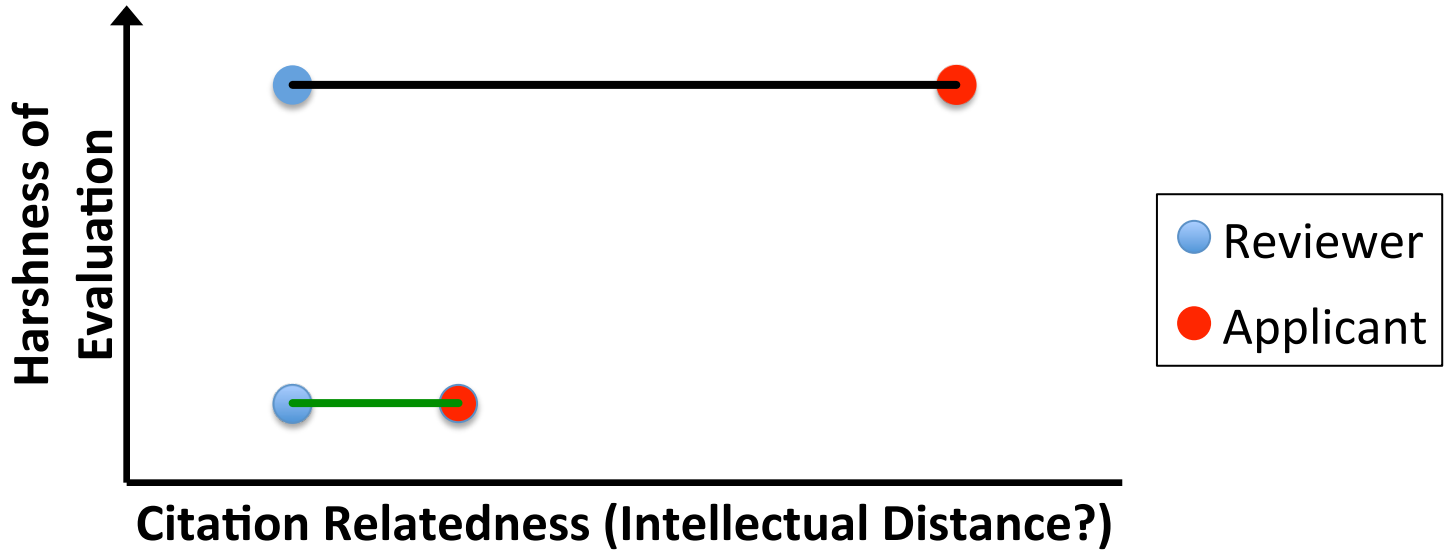
- Information sampling effect: higher expertise (likely shorter intellectual distance), more information sampled
- Increased sampling is skewed toward weaknesses; harsh evaluations

Contrasting Results

- Li (2013) study of **un-blinded** NIH review panels
- Found higher degree of relatedness (***citation linkage***) between applicant and reviewer yields more favorable evaluations



Contrasting Results



- More "related" reviewers sample additional information and make inferences about application quality (therefore may be less harsh)
- Relatedness may be indirect measure of intellectual distance?

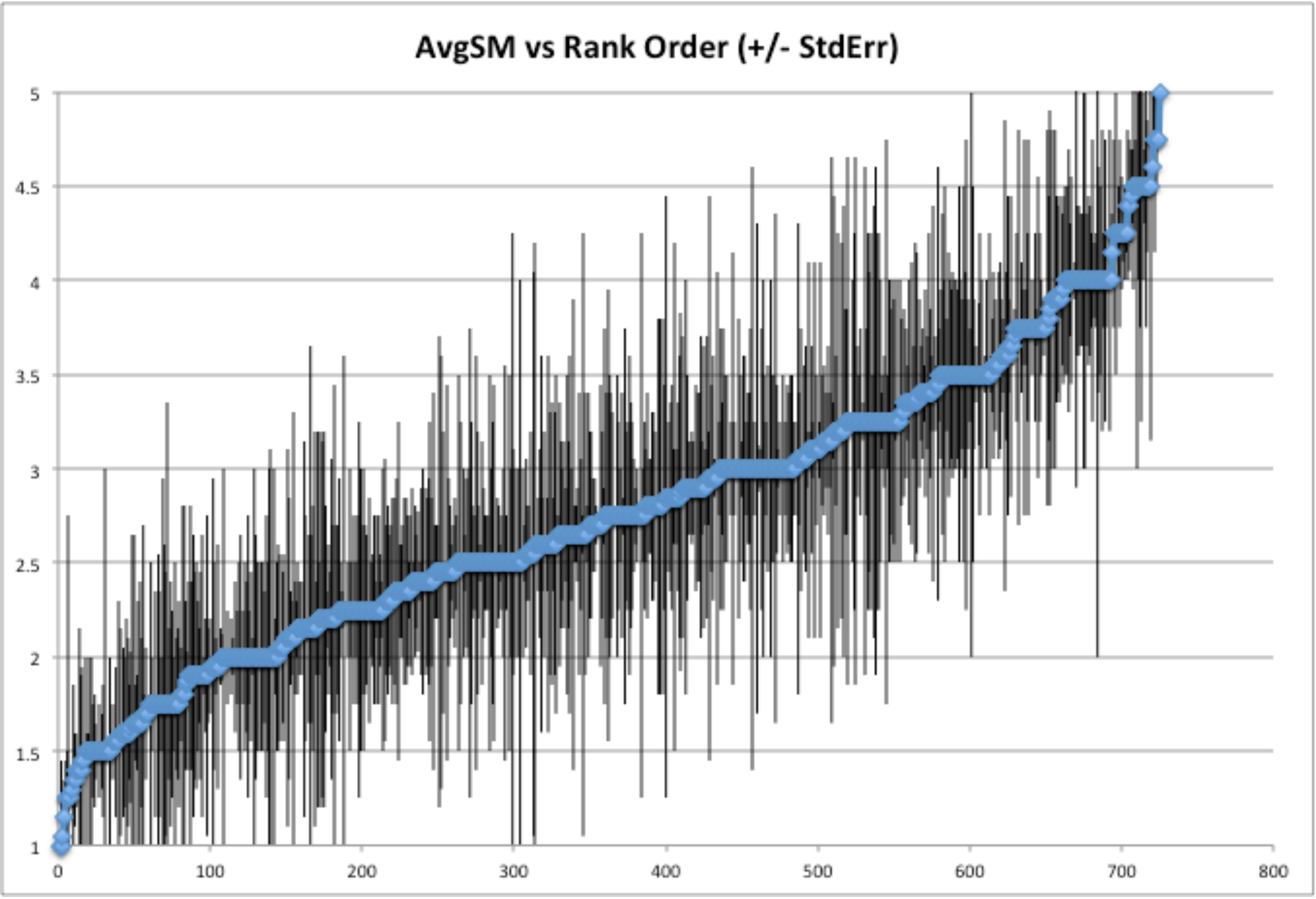
AIBS Hypothesis

- AIBS data: scoring (**scientific merit [SM]** and self-assessed **reviewer expertise [RE]**)
- SM vs. RE: **higher expertise, harsher evaluations/scoring**
- However, in **un-blinded** scenario, relationship will be **sensitive to reviewer and applicant seniority**

Retrospective Analysis of AIBS Peer Review Data

- **Un-blinded** peer review program of biomedical research applications (anonymized scoring/commentary)
- 1,450 individual reviews of 725 applications (2009 to 2012)
- **SM** scale: 1 – 5; 1 is highest merit
- **RE** scale: 1 – 5; 1 is highest expertise
- Examine relationship between **SM** and **RE**

Reviewer Demographics (Total Reviewers = 1044)			Applicant Demographics (Total Proposals = 725)	
	N	**%**	**N**	**%**
Gender				
M	800	77	619	85
F	244	23	106	15
Position				
Junior	277	27	130	18
Non-Junior	767	73	595	82
Sector				
Acad	961	92	429	59
Non_Acad	83	8	296	41
Degree				
No MD	718	69	476	66
MD Training	326	31	249	34


AvgSM vs Rank Order (+/- StdErr)
5
4.5
4
3.5
3
2.5
2
1.5
1
0
100
200
300
400
500
600
700
800

Analytic Approach

- Hierarchical data
- Multi-level multiple regression approach
- Individual reviewer evaluations (level 1) nested in application groupings (level 2)
- Random intercept model:

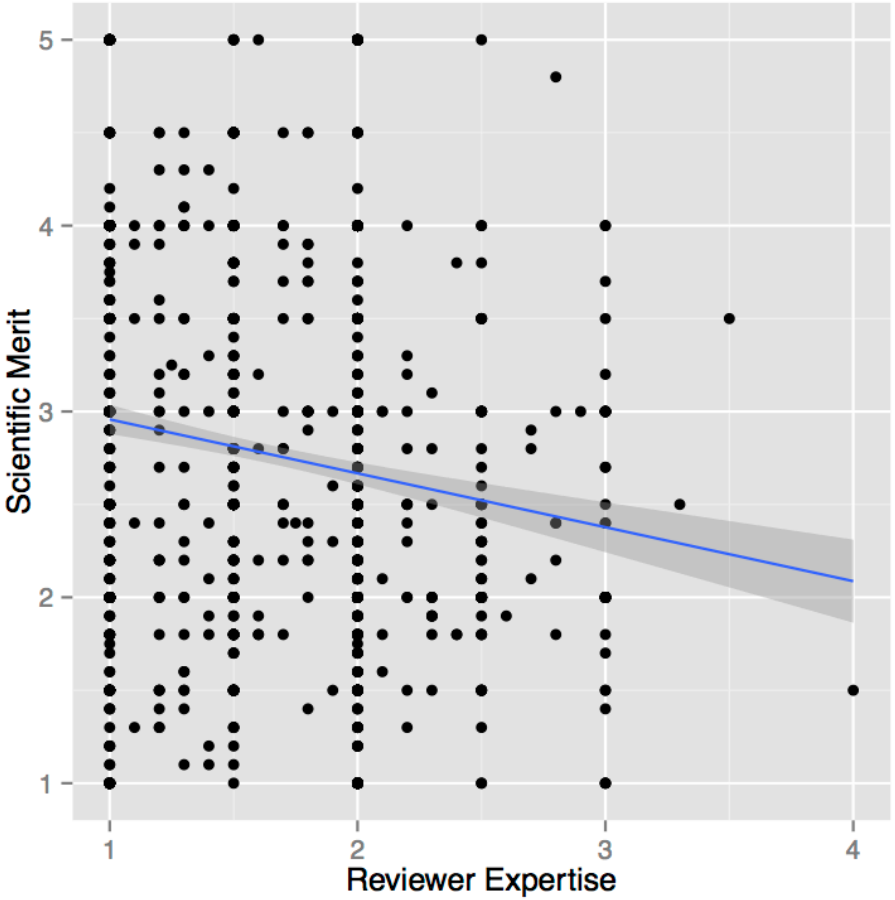
$$\mathbf{Y_{ij} = X_{hij}\beta_h + \beta_0 + \mu_{0j} + \varepsilon_{ij}}$$

Y_{ij} = scientific merit of reviewer *i* of the *j*th application
X_{hij} = vector of *h* independent variables with *h* coefficients β_h
β_0 = constant intercept
μ_{0j} = random intercept varies across applications
ε_{ij} = residual error component

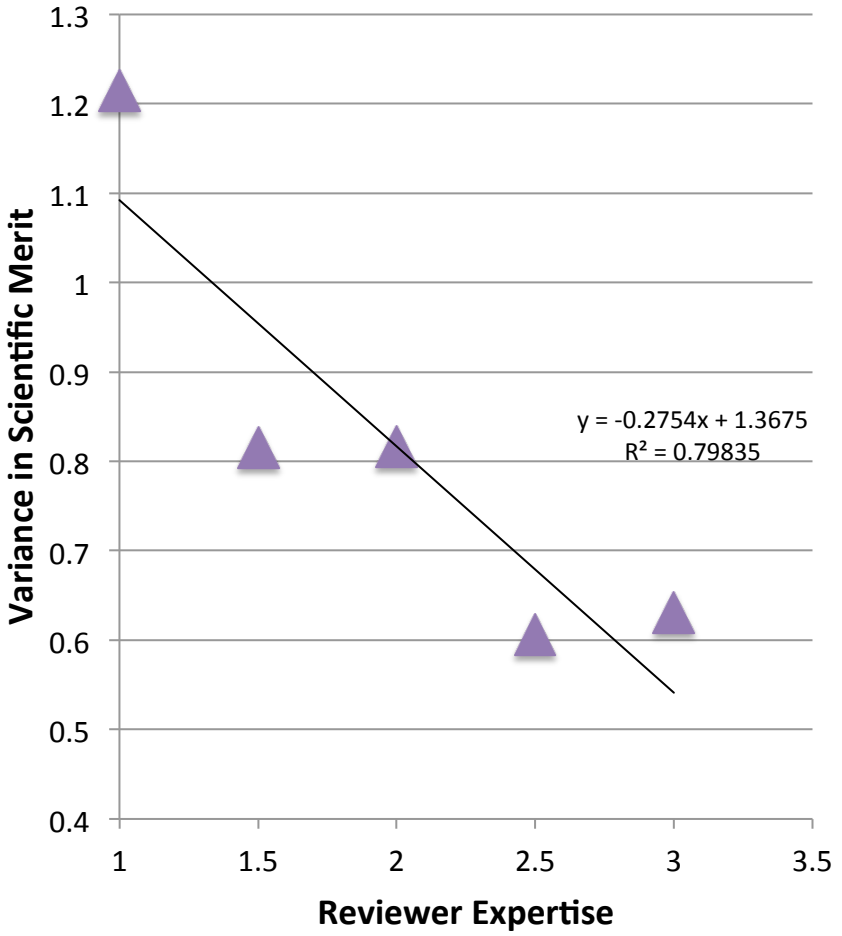
Effect Type	Model 1: Baseline across applications	Model 2: RE	Model 3: RE + Reviewer Demographics	Model 4: RE + Reviewer and Applicant Demographics	Model 5: RE + Reviewer Demographics + Applicant Position
Random Effects					
Variance Across Proposals	0.219 (0.042)*	0.213 (0.042)*	0.204 (0.042)*	0.197 (0.042)*	0.201 (0.043)*
Variance Across Assesors	0.740 (0.023)*	0.722 (0.023)*	0.716 (0.023)*	0.713 (0.023)*	0.714 (0.023)*
Fixed Effects					
Intercept	2.77 (0.03)*	3.24 (0.08)*	3.13 (0.12)*	3.07 (0.17)*	3.04 (0.13)*
Reviewer Expertise	_____	-0.28 (0.05)*	-0.19 (0.07)*	-0.20 (0.10)*	-0.16 (0.07)*
Deviance (previous model)					
Change in 2LL	38.9*	36.8*	21.5*	14.0	7.3* (compared to Model 3)

* Indicates statistical significance $p<0.05$

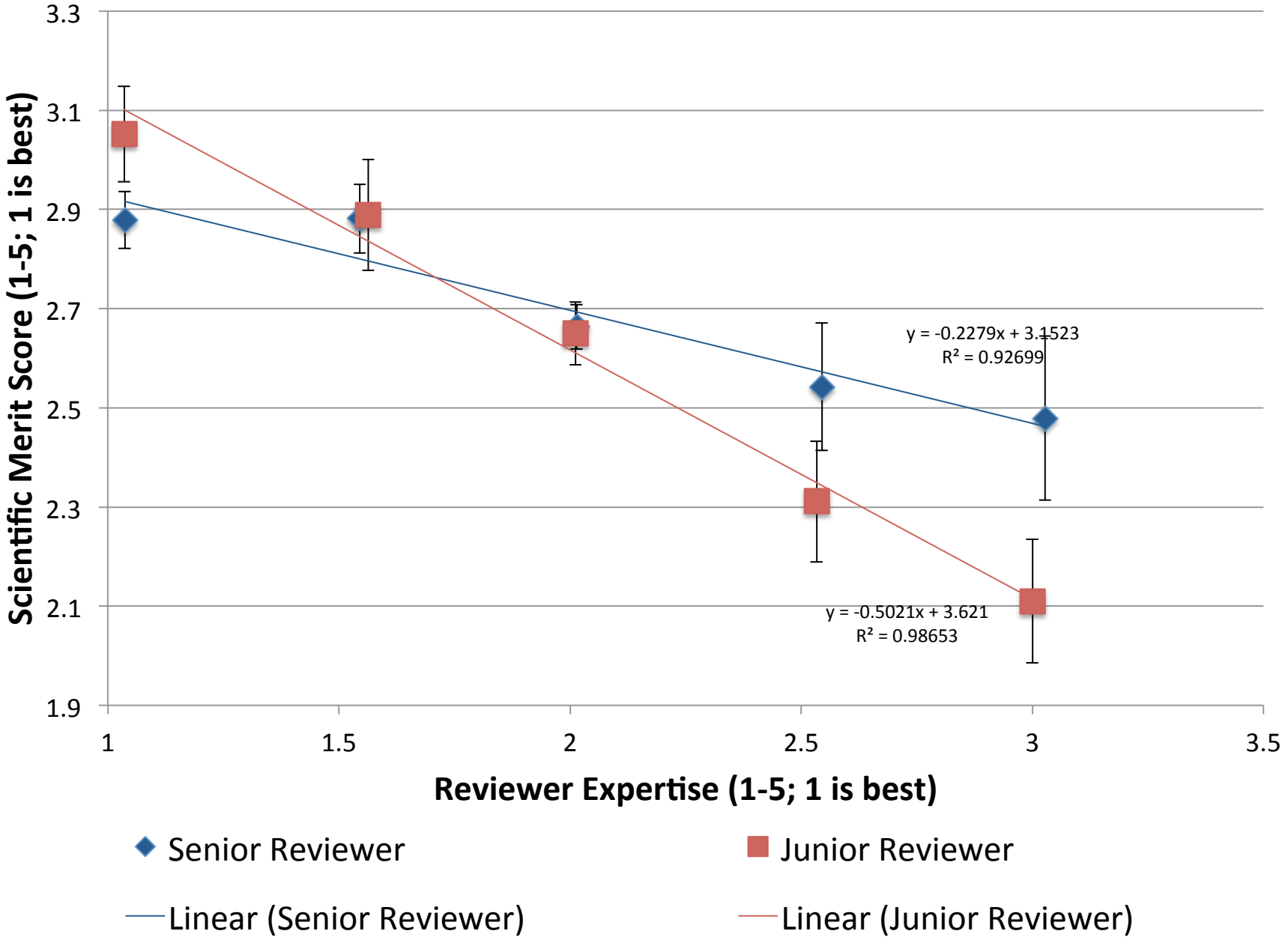
SM vs. RE



SM variance vs. RE



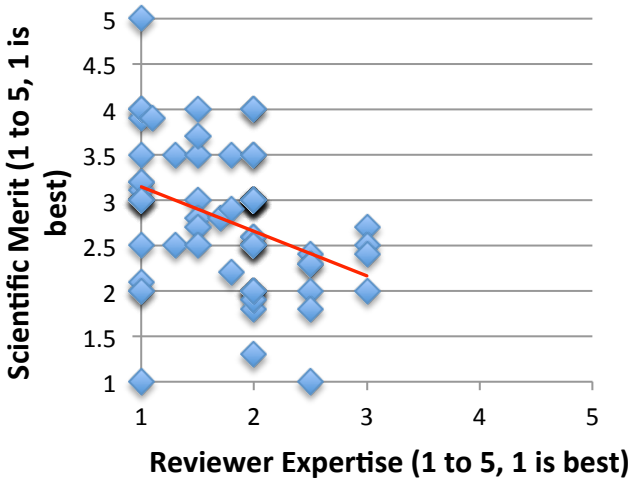
Model 5: RE + Reviewer Demographics + Applicant Position	
Random Effects	
Variance Across Proposals	0.201 (0.043)*
Variance Across Reviewers	0.714 (0.023)*
Intra-proposal Correlation	0.22*
Inter-Rater Reliability	0.36
Main Effects	
Intercept	3.04 (0.13)*
Reviewer Expertise (RE)	**-0.16 (0.07)***
Reviewer Gender (RevF)	-0.02 (0.20)
Junior Reviewer (RevJ)	**0.41 (0.19)***
Non-Academic Reviewer (RevNonAc)	-0.21 (0.29)
Reviewer with MD Degree (RevMD)	0.08 (0.17)
Junior Applicant (PIJ)	**0.48 (0.22)***
Interaction Effects	
Reviewer Expertise * Reviewer Gender	-0.03 (0.11)
Reviewer Expertise * Junior Reviewer	**-0.22 (0.11)***
Reviewer Expertise * Non-Academic Reviewer	-0.06 (0.17)
Reviewer Expertise * Reviewer with MD Degree	-0.07 (0.10)
Reviewer Expertise * Junior Applicant	-0.19 (0.12)

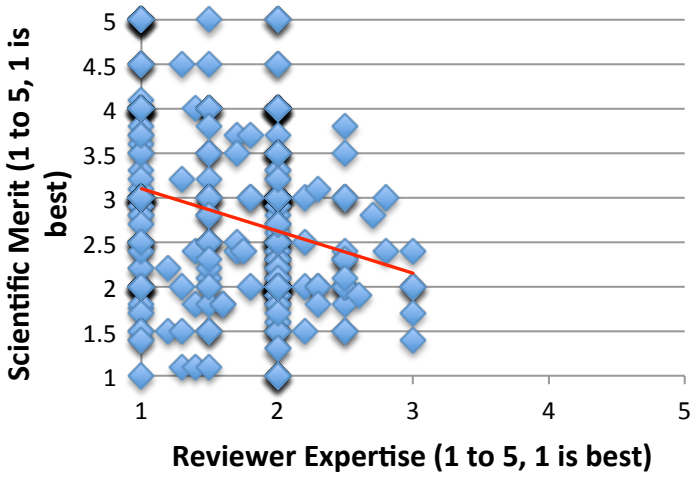

Scientific Merit Score (1-5; 1 is best)
3.3
3.1
2.9
2.7
2.5
2.3
2.1
1.9
1
1.5
2
2.5
3
3.5
Reviewer Expertise (1-5; 1 is best)
y = -0.2279x + 3.1523
R² = 0.92699
y = -0.5021x + 3.621
R² = 0.98653
Senior Reviewer
Junior Reviewer
Linear (Senior Reviewer)
Linear (Junior Reviewer)

Junior Applicant

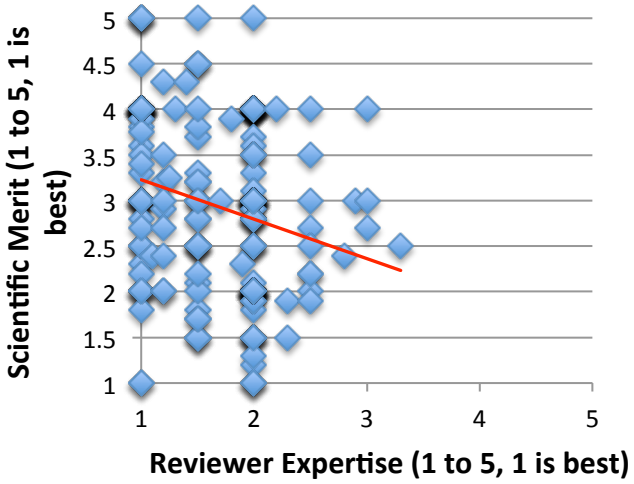
Non-Junior Applicant

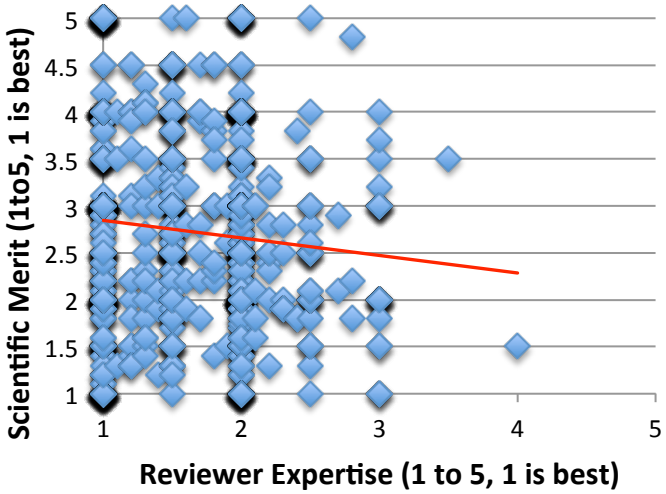
Junior Reviewer





Non-Junior Reviewer





Conclusions I

- We found **RE linearly correlated to SM** in **un-blinded** review
- Found **shorter intellectual distance** leads to **harsher evaluations**: information sampling
- However, SM vs. RE relationship **sensitive to applicant and reviewer seniority**

Conclusions II

- Senior reviewers may heavily weigh applicant track record
- Track record may compensate for any perceived methodological hurdles
- Intuition

Conclusions III

- Further research:
  - What types of information reviewers are sampling
  - How precisely reviewers are weighting this information

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