

Needle in a Haystack: Are those 'rare' minutiae in palms really as uncommon as you think?

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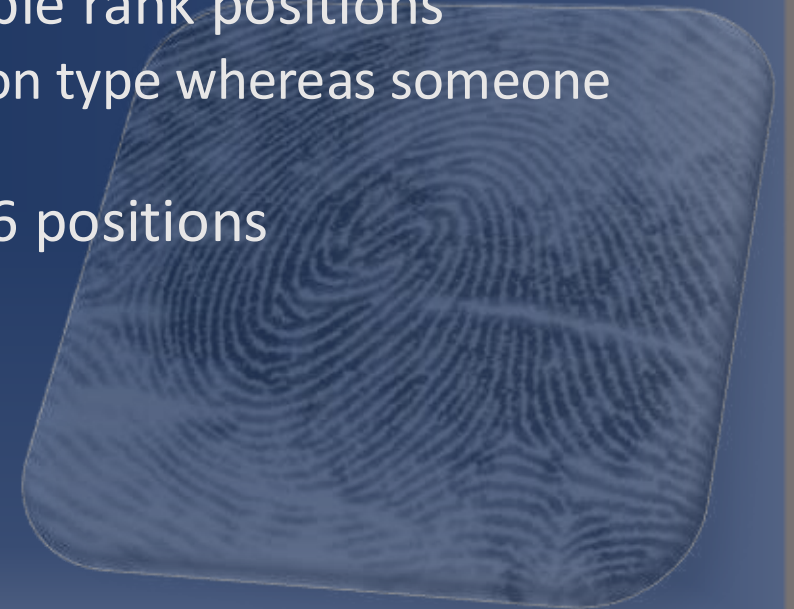
RTI Partners:

John Grassel, Ivy Walker, Mikalaa Martin



Suitability, Sufficiency, and the “Mental Database”

- We give extra weight to what we perceive as “rare” features
- Usually based on a “gut feeling” that is experience based
- Osterburg (1964) demonstrated that our “gut feelings” are not consistent
 - 82 examiners ranked 10 minutia types from most common to most rare
 - Ranks for 4 of the 10 types were spread across 9 possible rank positions
 - For 3 of the types, someone said it was the most common type whereas someone else said it was the second **least** common type
 - No minutia type ranks were spread across fewer than 6 positions



Pattern Force Areas Matter



a



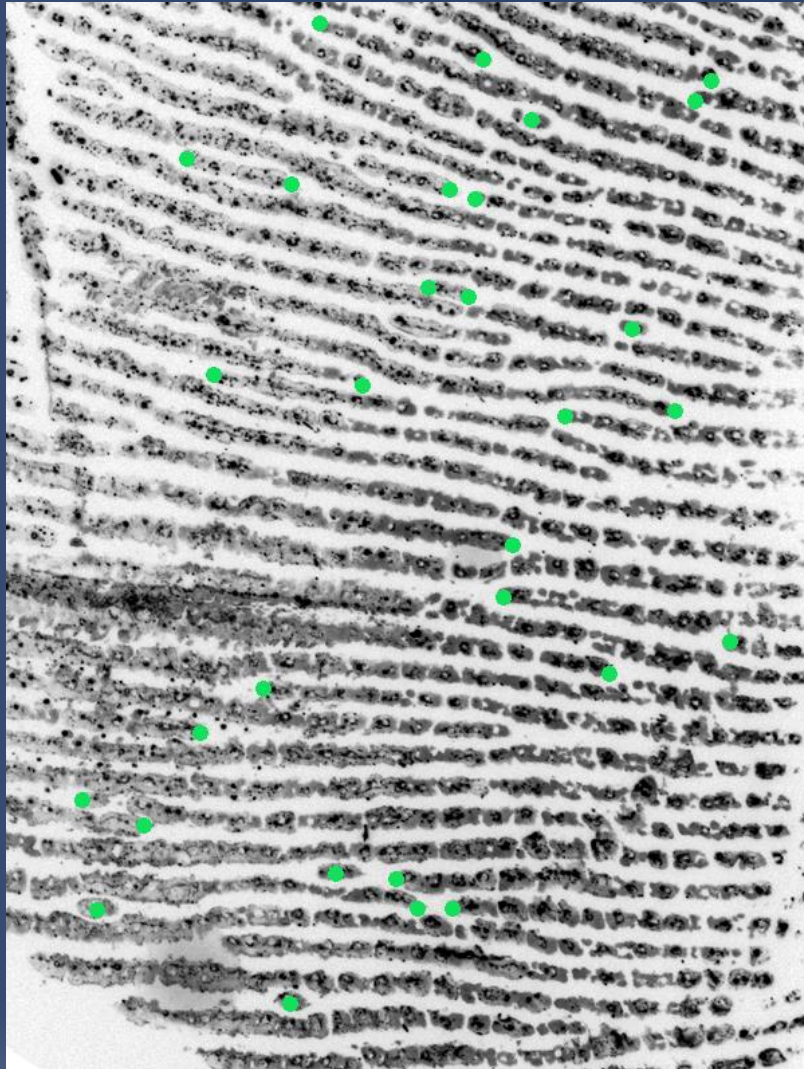
b

...and these will vary between fingers and palms!



We tend to treat fingers and palms the same

If a feature is rare in fingers, it must be rare in palms, right?



Three phases to this project:

- 1) Survey examiner perceptions
- 2) Measure and compare relative minutia rarity in palms and fingers
- 3) Provide training and policy recommendations



Current Work – Developing Interface

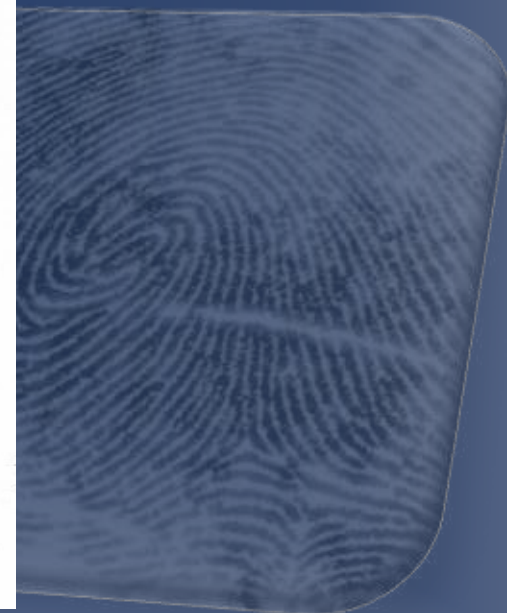
- Minutiae extraction
- Superimposition on images
- Defining bounding boxes
- Trainees fix annotations
- Trainees annotate combined minutiae according to definitions
- Software amalgamates counts in various bounding boxes



Regions to sample

- Selecting Regions
 - We will not annotate the entire palm
 - Pristine images will be used
 - Defined areas/boxes will be used
- Areas will include:
 - Clean Delta
 - Interdigital 2
 - Hypothenar pattern area
 - Hypothenar under top crease (mound/flat area)
 - NO THENAR





Defining Minutiae

- 15 combined minutiae types will be cataloged
 - Plus, Ridge ending and Bifurcation, for a total of 17
- Definitions will be used to reduce variability
- Names/definitions will follow those developed by Quigley-McBride, Eldridge, and Gardner (2024) for consistency





An independent ridge with a length that is less than two times its width.



Two bifurcations that face one another and merge together.



Two ridge endings on the same ridge that face in opposite directions.



A ridge that is interrupted by a small discontinuity resulting in the appearance of two ridge endings facing one another across a small gap. Failures to record continuously are not ridge breaks.



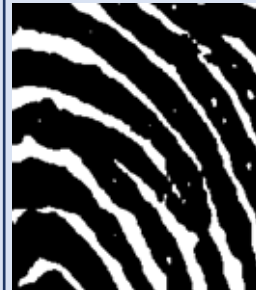
Two bifurcations sharing a single stem and opening away from one another.



Two ridge endings that face one another but alter their courses to avoid collision and overlap one another for a small distance.



A ridge that connects two adjacent ridges by travelling between them for not more than the width of 3 ridges. Tend to be close to perpendicular.



A ridge that connects two adjacent ridges by travelling between them more than the width of 3 ridges. Tends to run nearly parallel.**



A ridge that alters course to zigzag between two ridge endings that face one another.



A bifurcation in which one leaf continues on while the other terminates in a ridge ending.



A bifurcation whose stem terminates in a ridge ending.



Three ridge endings facing one another in an alternating pattern, with none of them touching, although they may overlap no further than the width of five ridges (or approx. 5 pores)**



Two bifurcations running adjacent to one another and facing the same direction in which the inner leaf of each bifurcation merges into a single ridge running between the two outer leaves, resulting in a shape resembling a capital M or W.**



Two bifurcations in sequence sharing the same stem in which the leaves protrude from the same side of the stem.



A single ridge splitting into three ridges at a single point, resembling a trident.

General Survey Counts

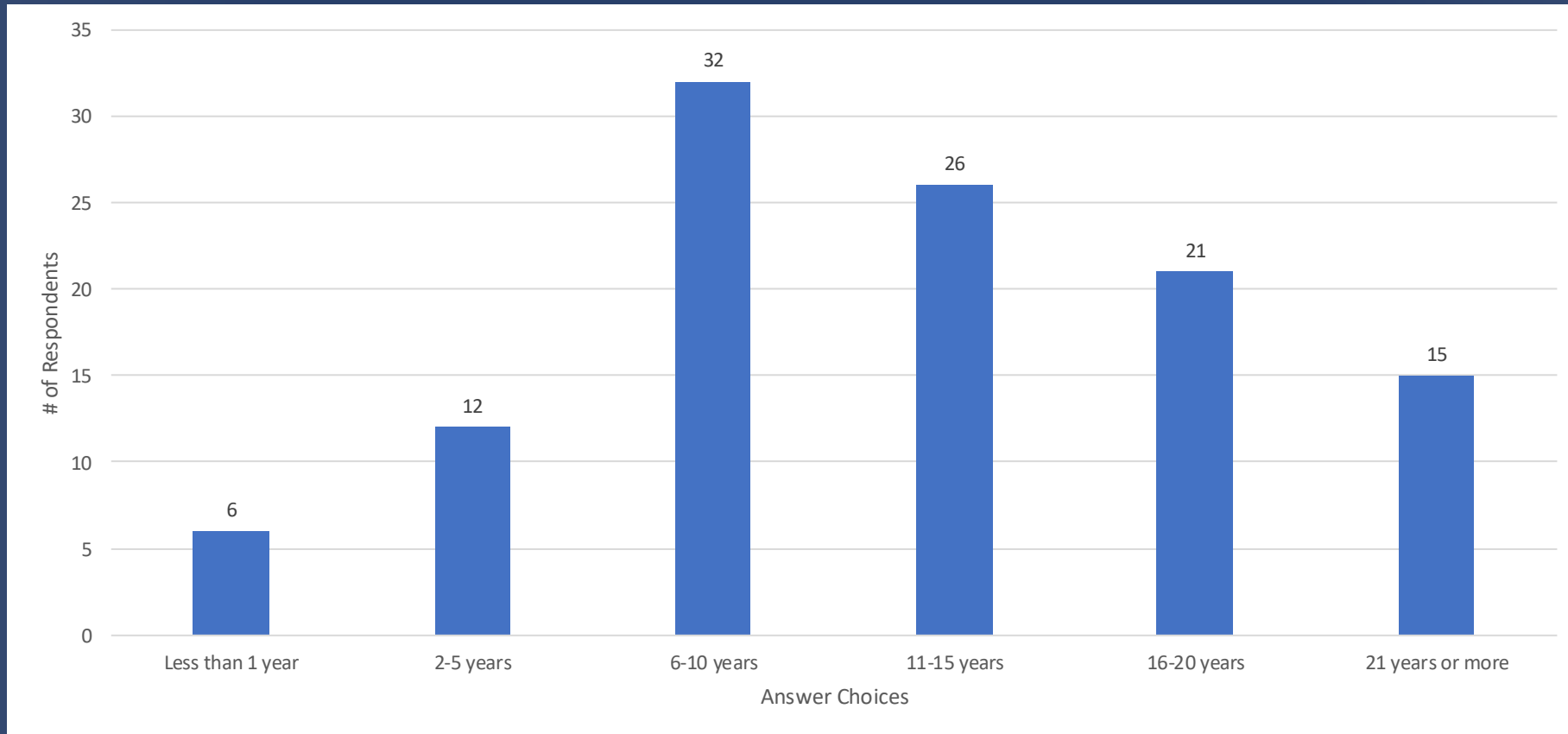
- 217 total responses
 - 111 complete responses
 - 100 partial responses (to varying degrees – only made it past consent to nearly finished)
 - 6 did not meet survey eligibility criteria and were marked complete following consent/indication they did not meet eligibility criteria
- Analysis based on 129 total responses (111 complete & 18 partial)



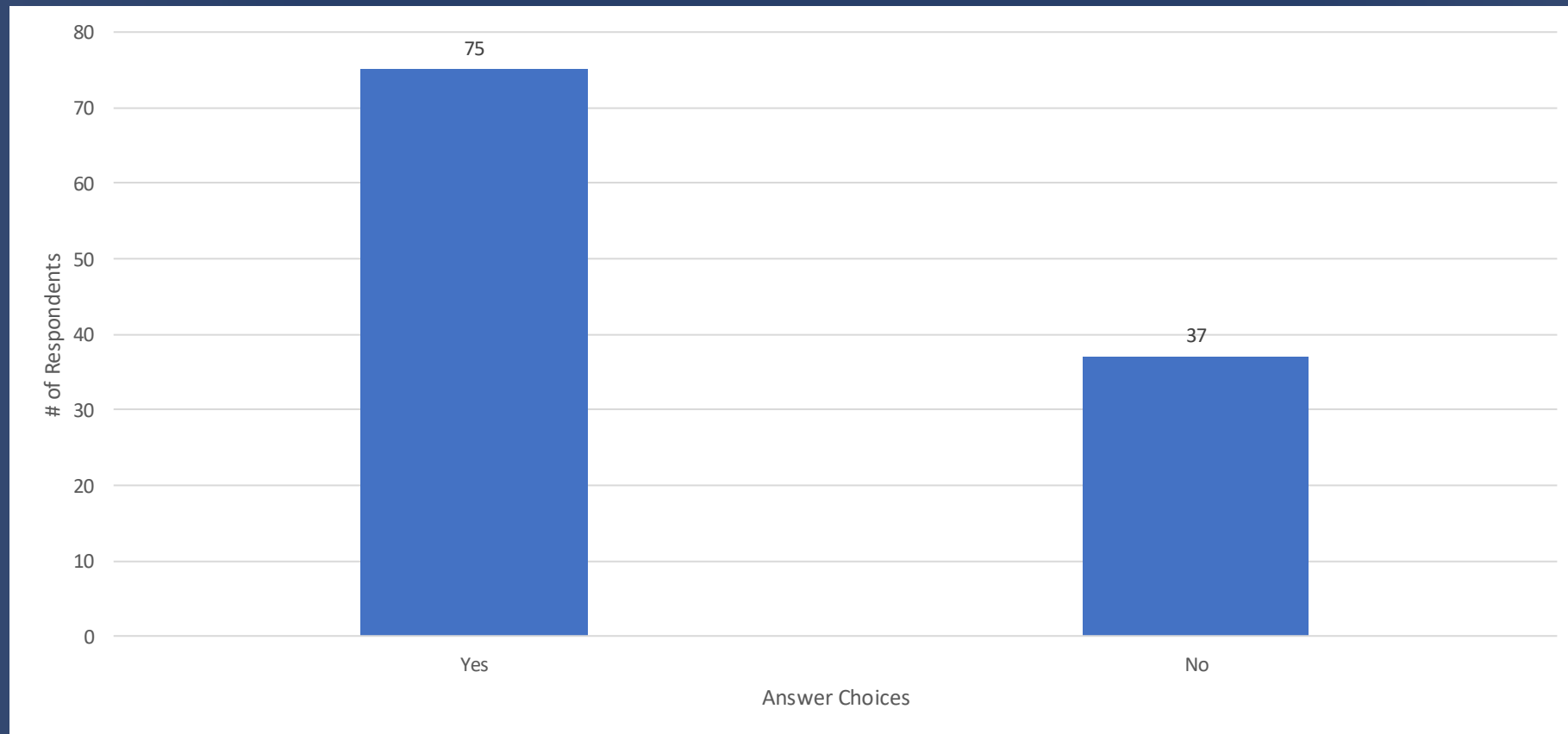
DEMOGRAPHIC / WORK STYLE QUESTIONS



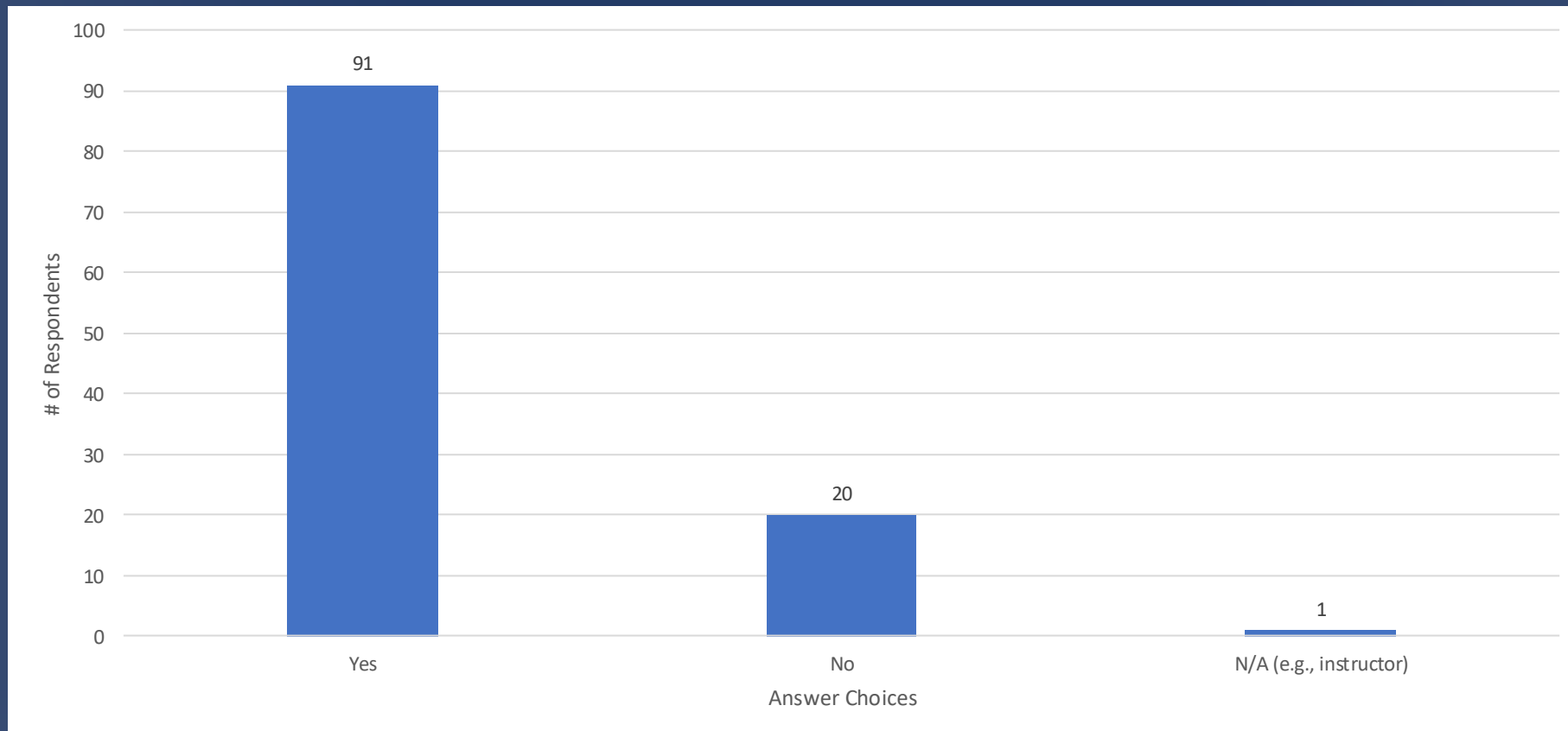
From the dropdown menu, select the answer that most closely correlates to your years of experience as a latent print examiner (not counting your training period). (n=112)



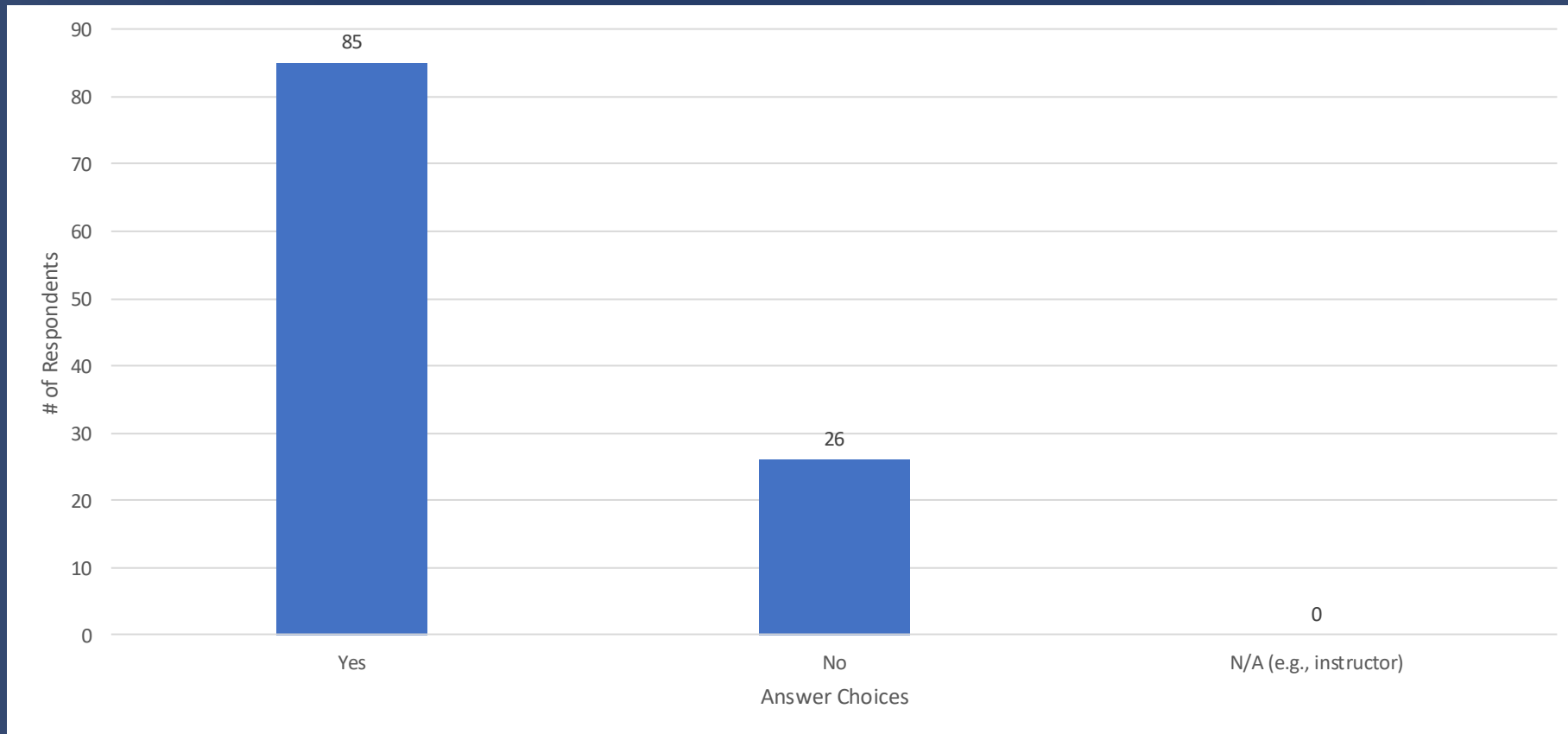
Do you possess certification as a latent print examiner by an external entity (e.g., International Association for Identification [IAI])? (n=112)



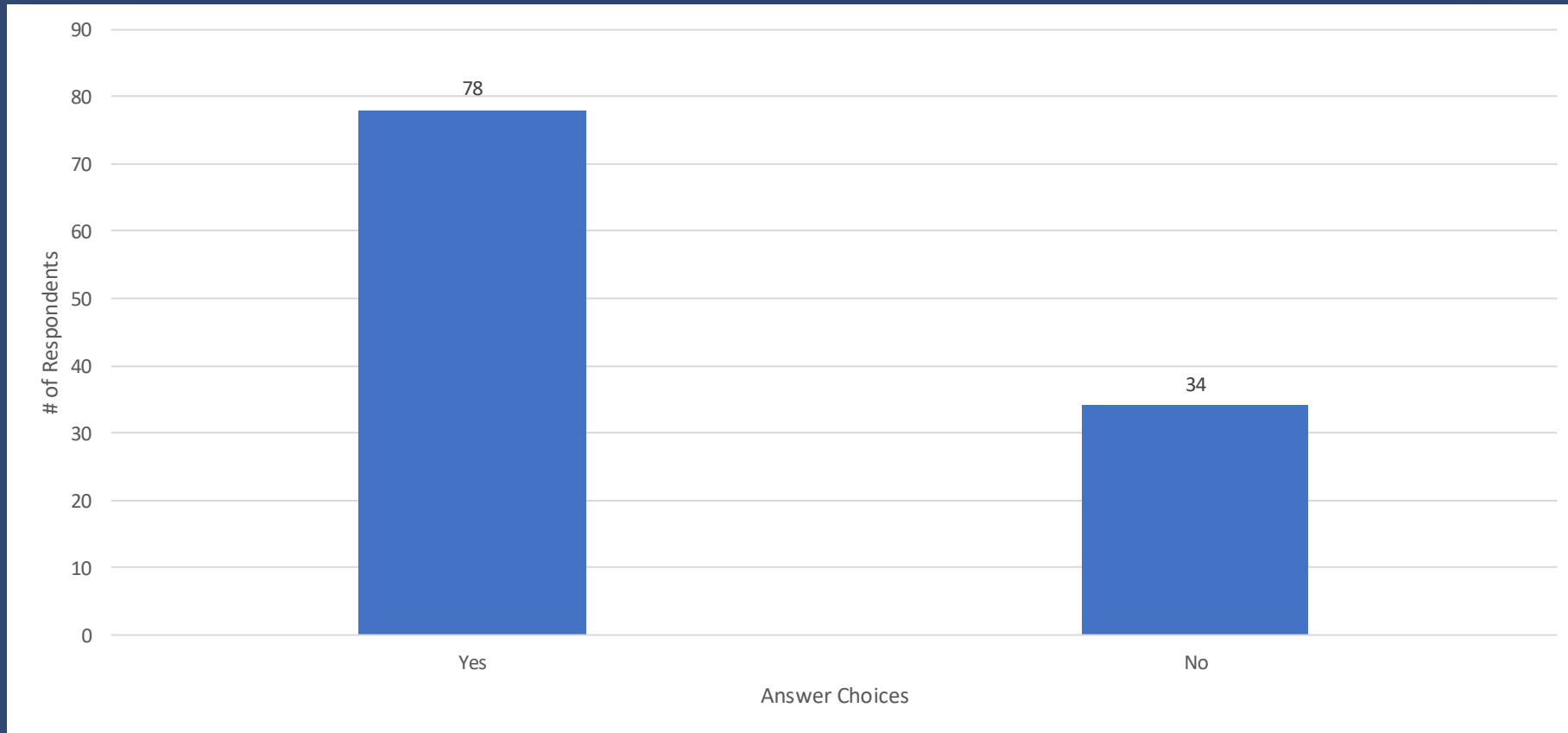
Is your agency accredited to ISO/IEC 17025 or ISO/IEC 17020 by an accrediting body (e.g., ANSI National Accreditation Board [ANAB], American Association for Laboratory Accreditation [A2LA])? (n=112)



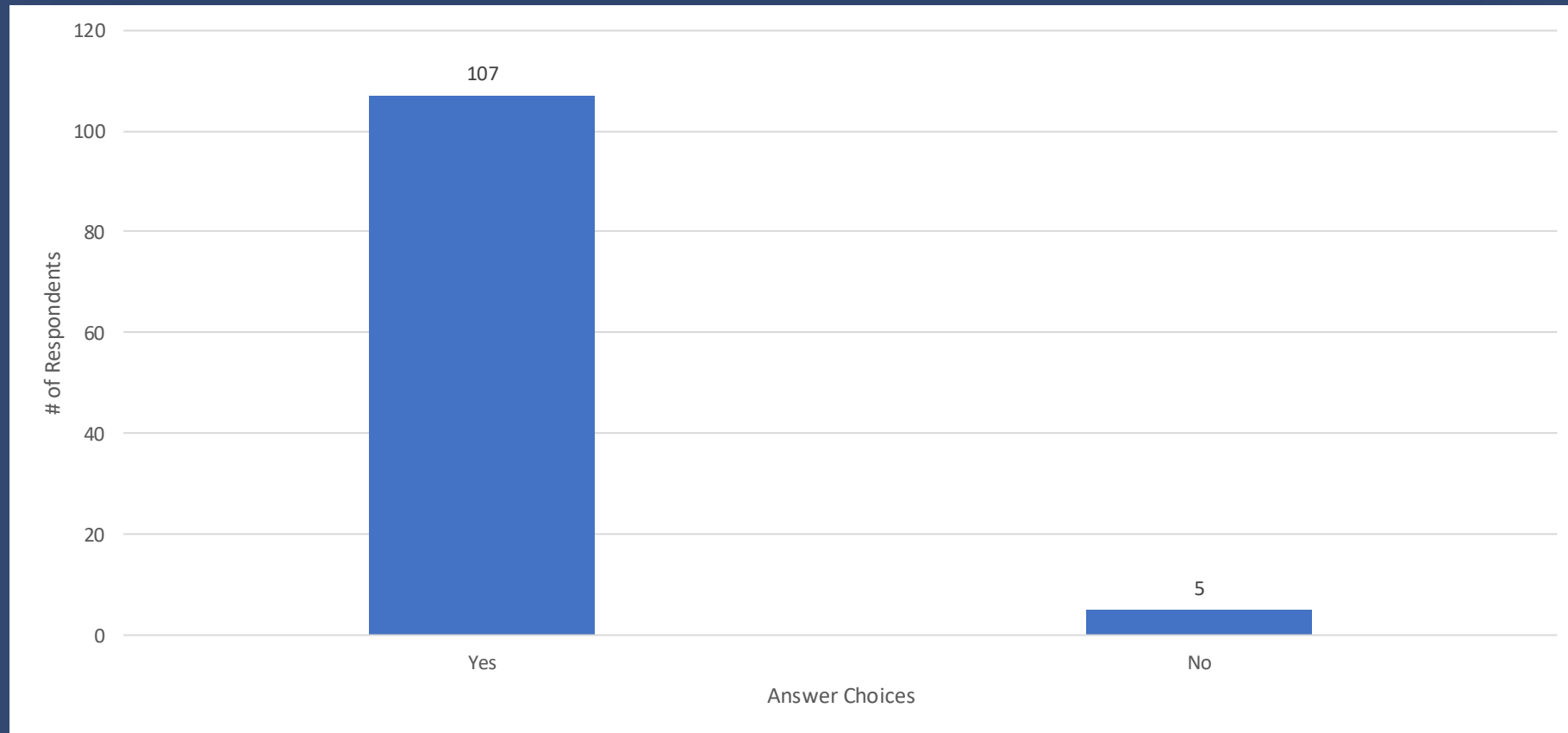
Is your agency an adopter of friction ridge standards produced by the Organization of Scientific Area Committees for Forensic Science (OSAC)? (n=111)



Do you consider the weight of combined minutiae differently when comparing fingers than when comparing palms? (n=112)



Do you assign different weights to different types of minutiae depending on your perception of their rarity? (n=112)



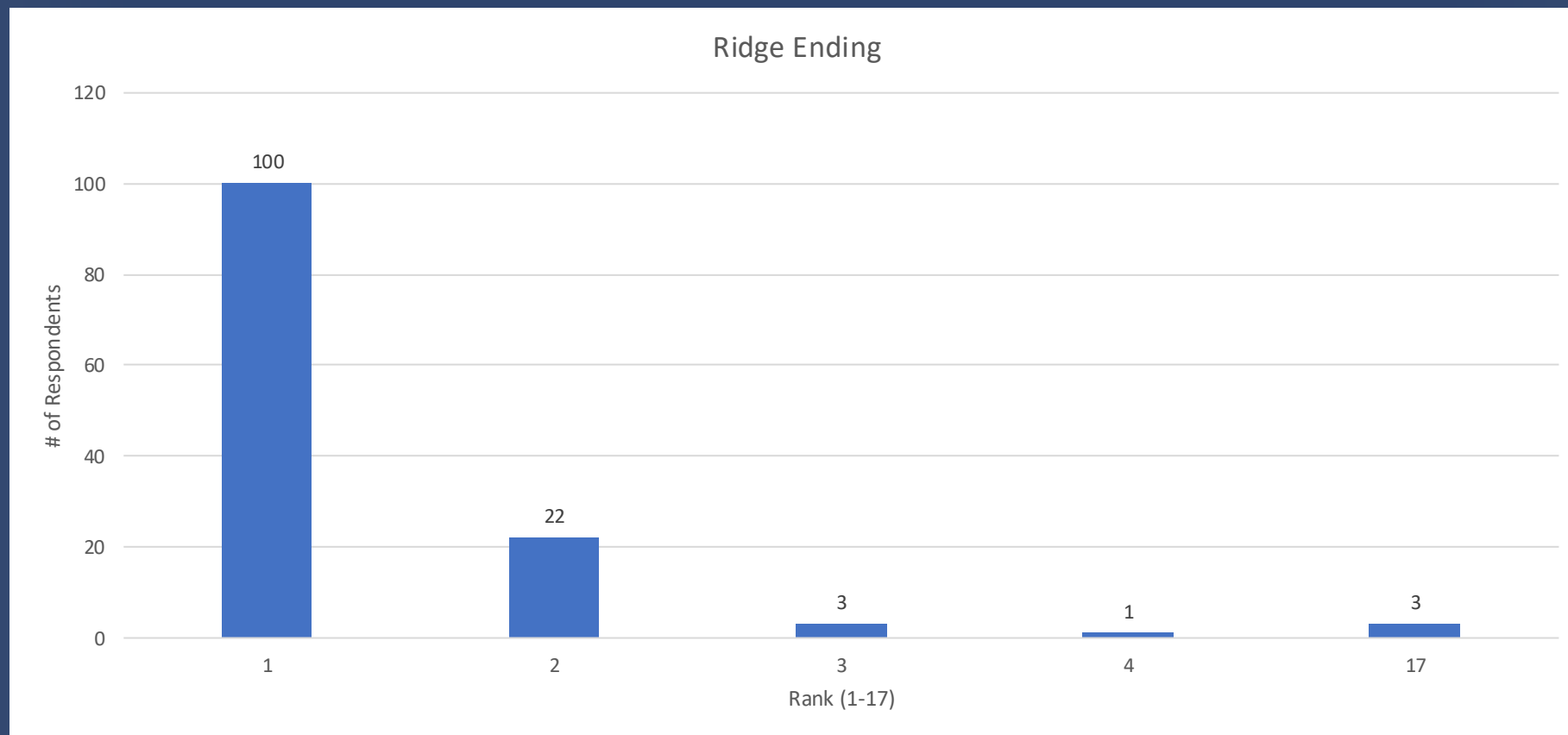
MINUTIAE TYPES: RANK ORDER (N=129)

Question: Rank the below minutia images in order from most common (1) to least common (17).

Minutiae to rank: Bifurcation, Bridge, Crossover, Divergence, Dock, Dot, Double Bifurcation, Enclosure, M, Over/Under, Ridge Break, Ridge Ending, Short Ridge, Spur, Switchback, Trifurcation, Tuning Fork.

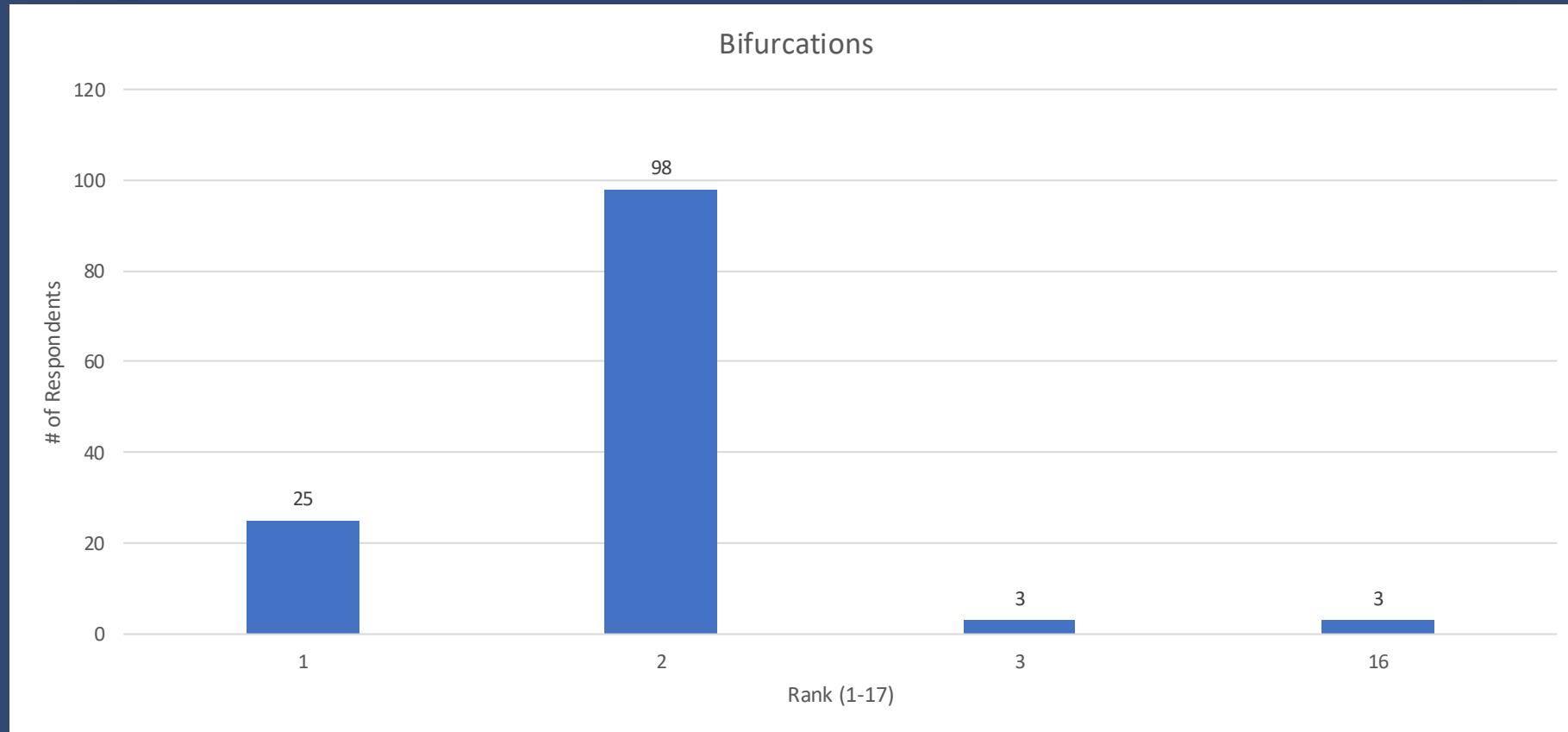


Ridge Ending Ranking (n=129)



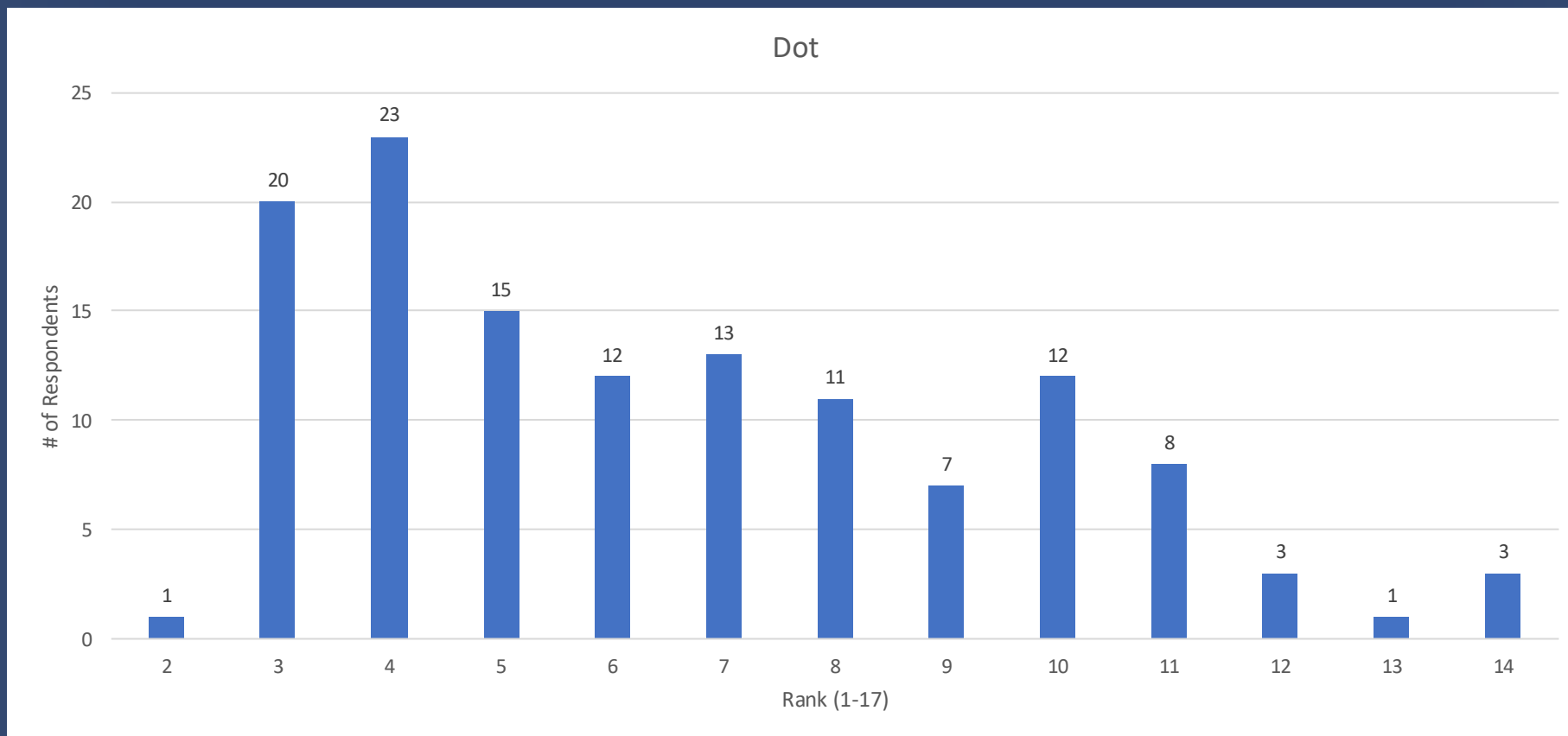
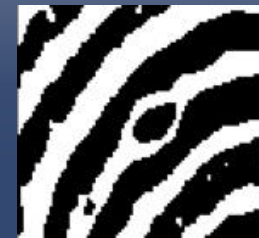
* Any rankings that had 0 respondents were omitted from the visualization.

Bifurcation Ranking (n=129)



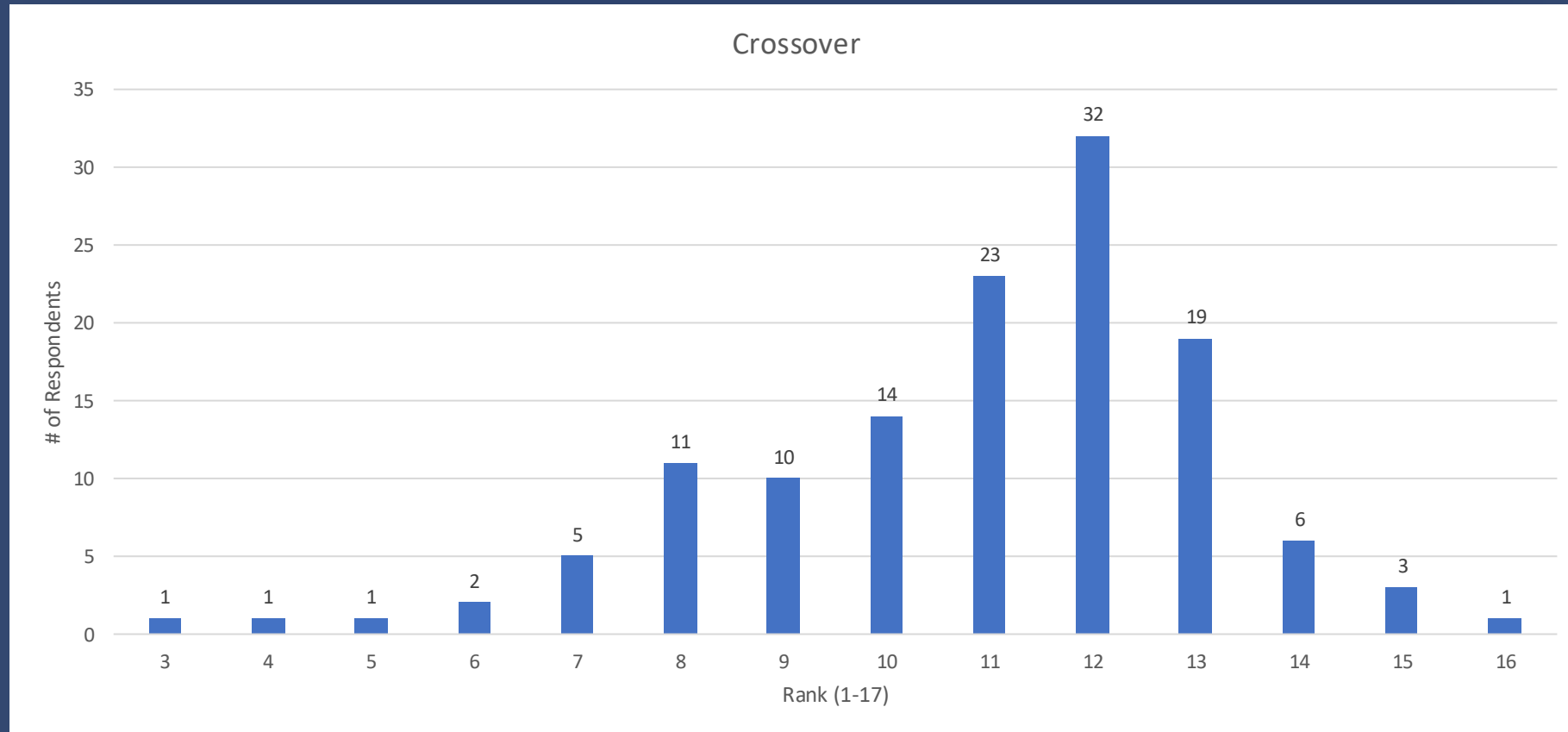
* Any rankings that had 0 respondents were omitted from the visualization.

Dot Ranking (n=129)



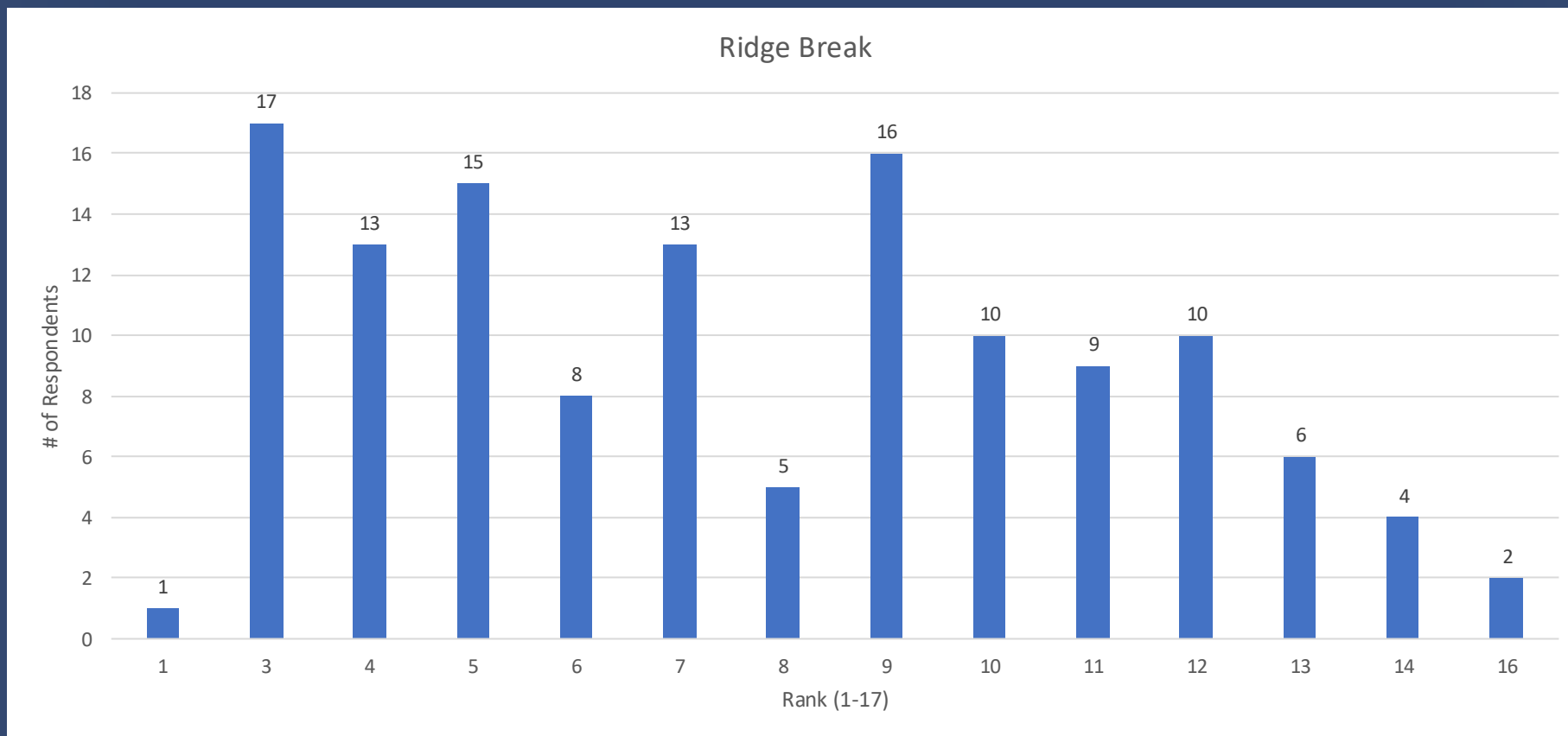
* Any rankings that had 0 respondents were omitted from the visualization.

Crossover Ranking (n=129)



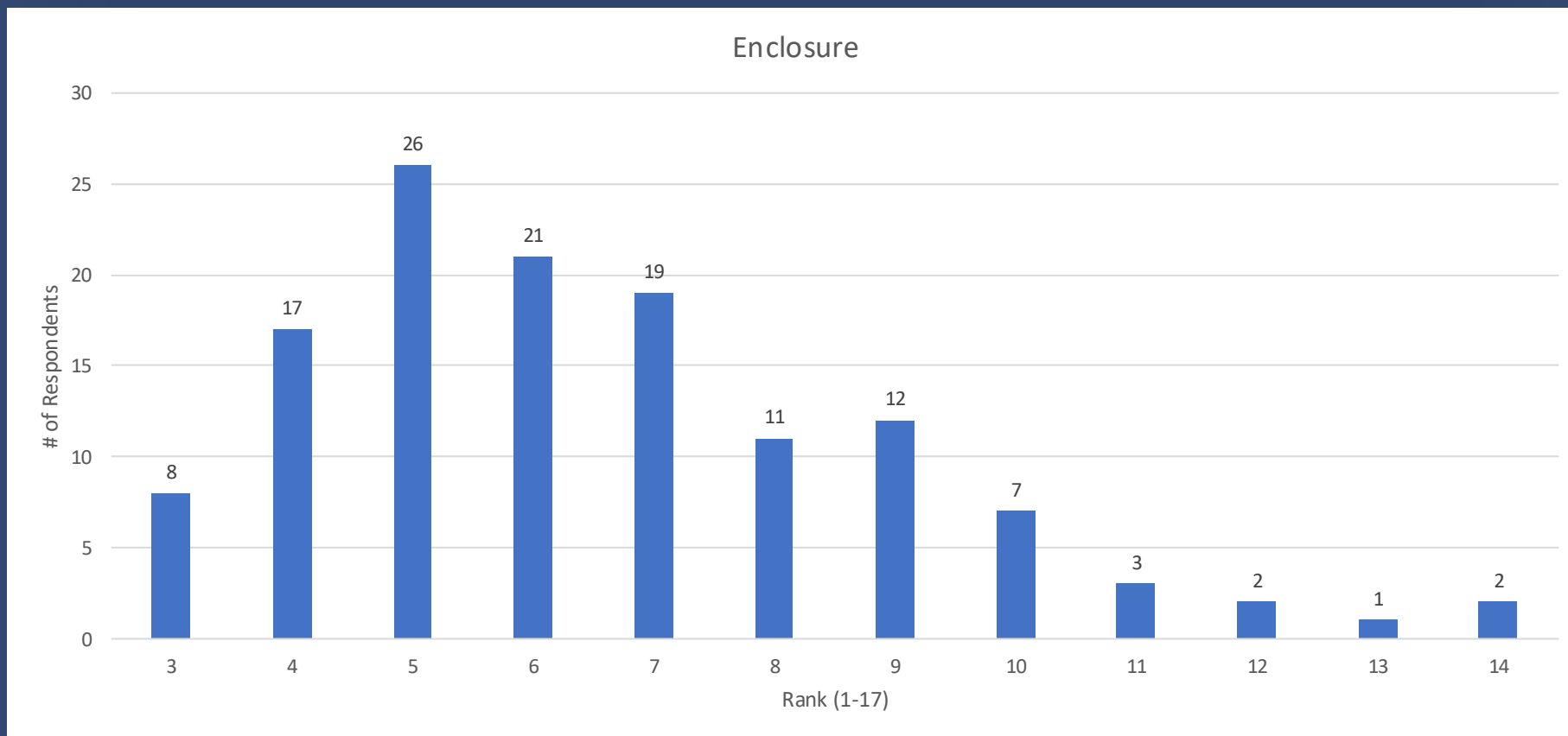
* Any rankings that had 0 respondents were omitted from the visualization.

Ridge Break Ranking (n=129)



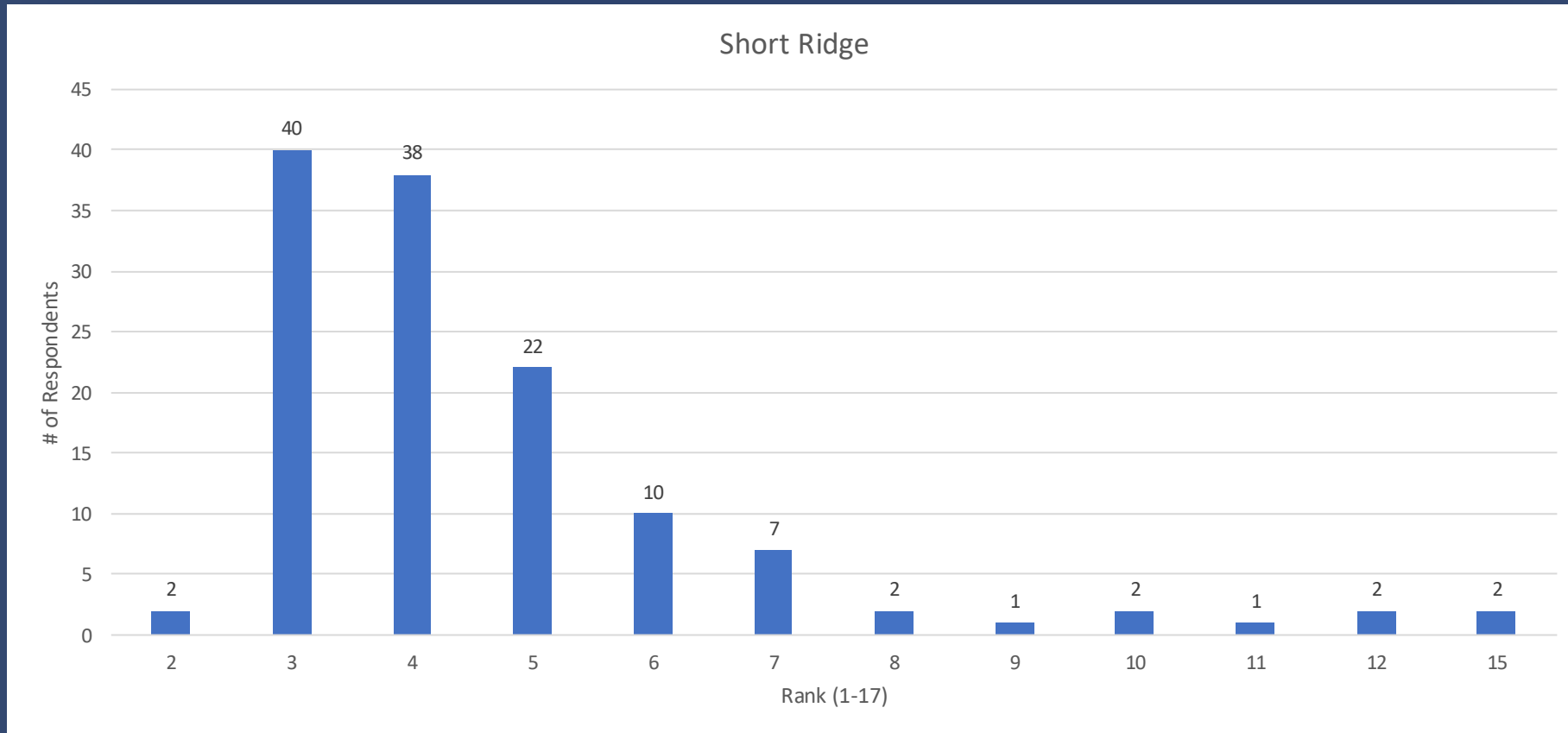
* Any rankings that had 0 respondents were omitted from the visualization.

Enclosure Ranking (n=129)



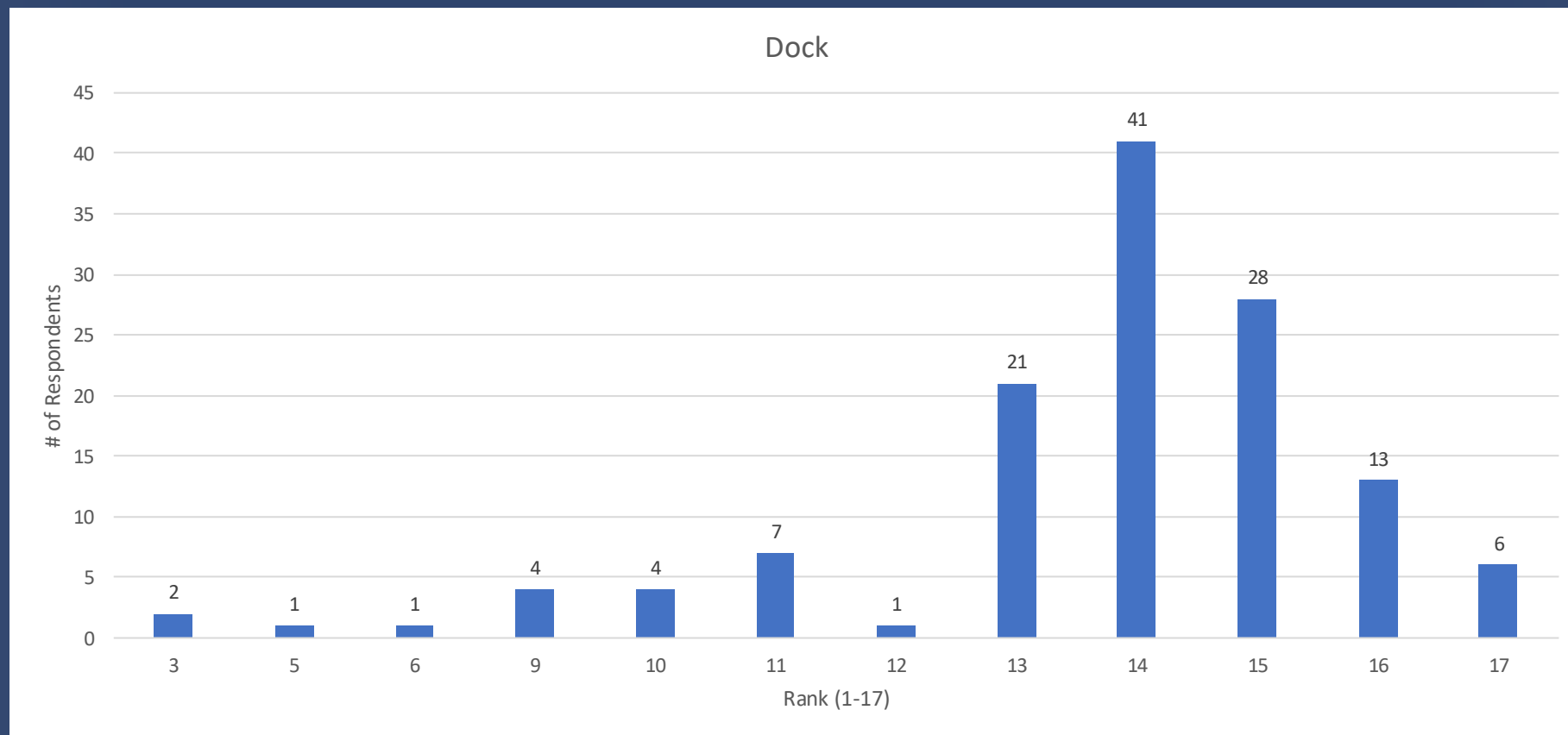
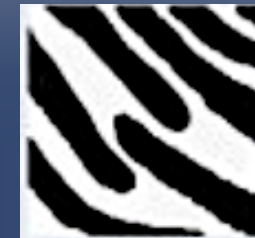
* Any rankings that had 0 respondents were omitted from the visualization.

Short Ridge Ranking (n=129)



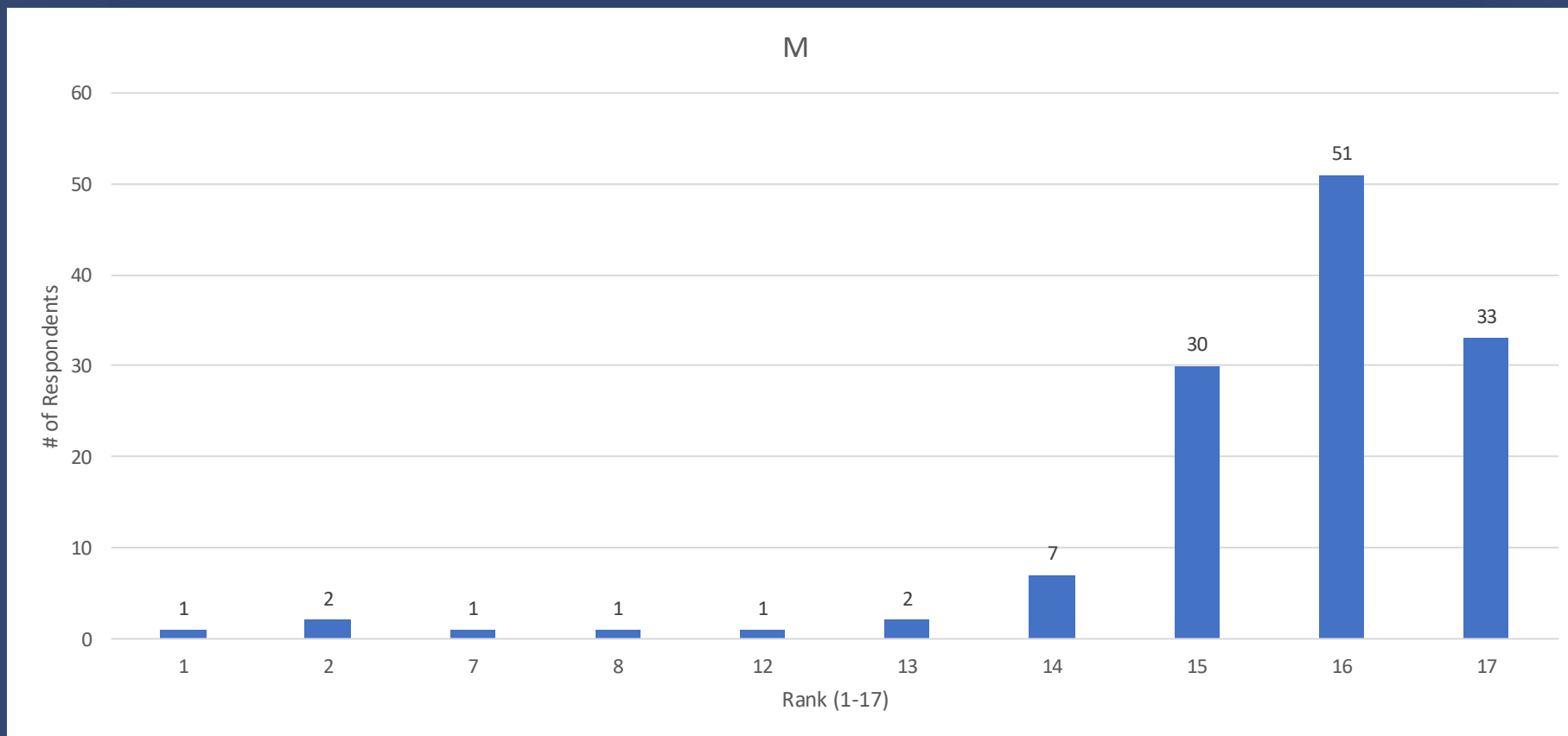
* Any rankings that had 0 respondents were omitted from the visualization.

Dock Ranking (n=129)



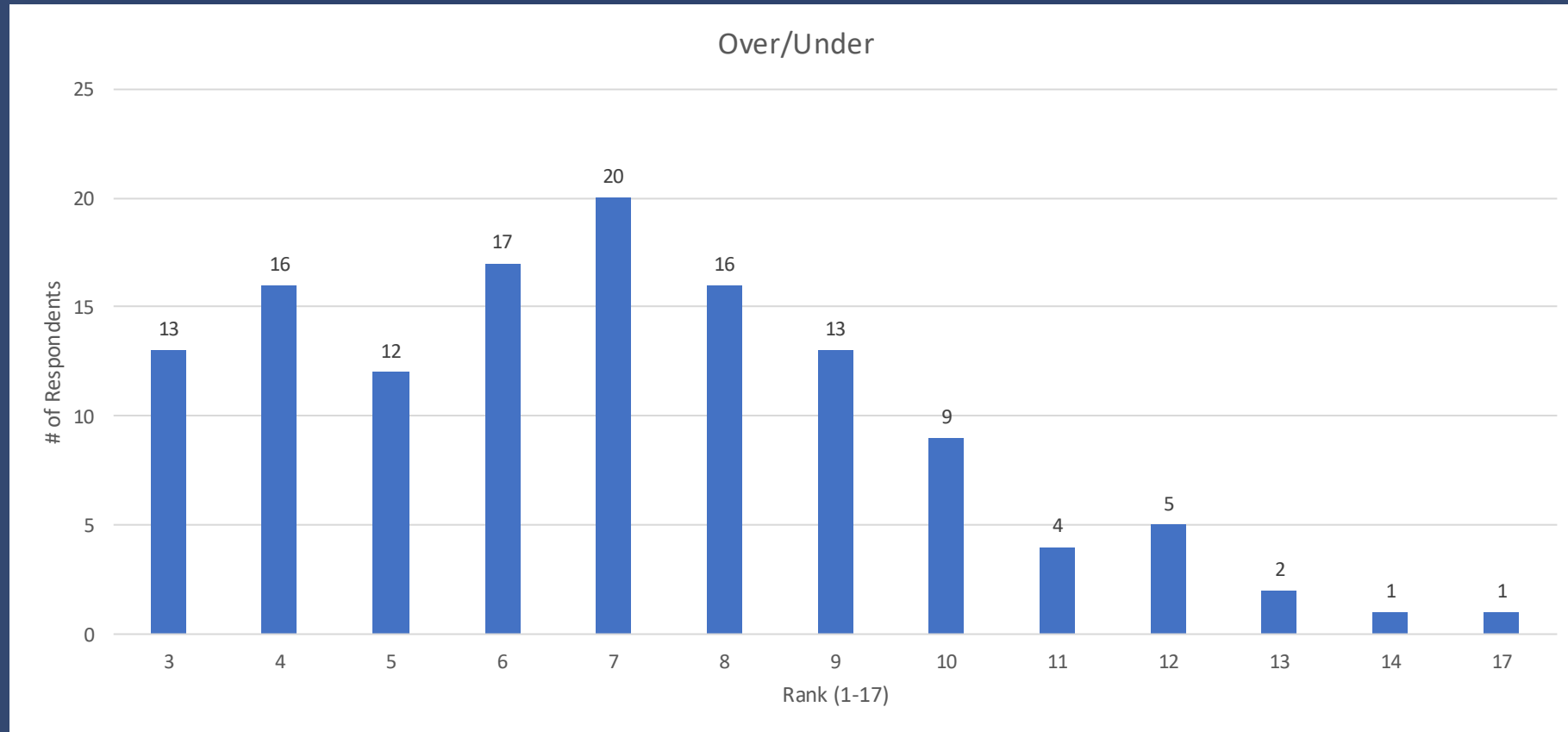
* Any rankings that had 0 respondents were omitted from the visualization.

M Ranking (n=129)



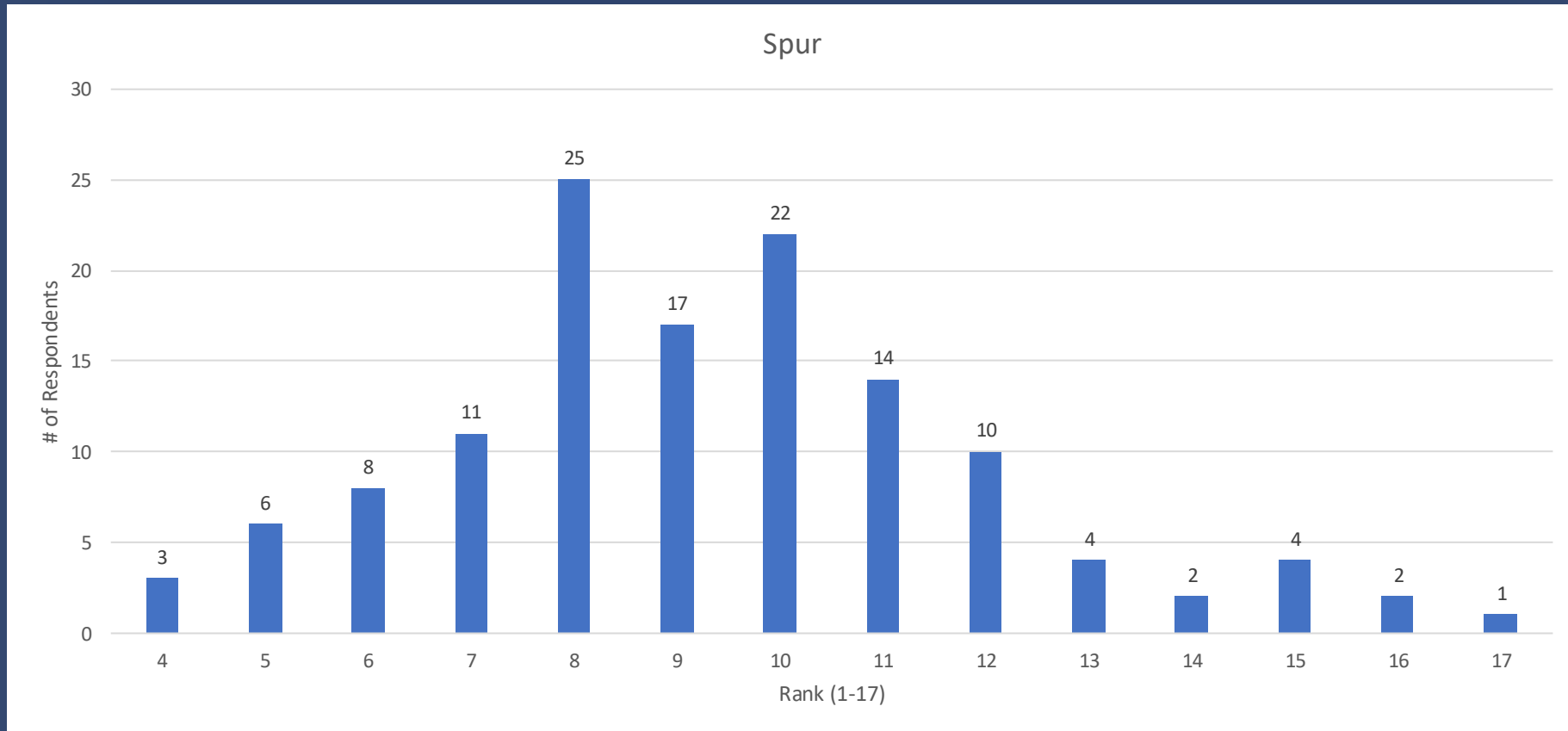
* Any rankings that had 0 respondents were omitted from the visualization.

Over/Under Ranking (n=129)



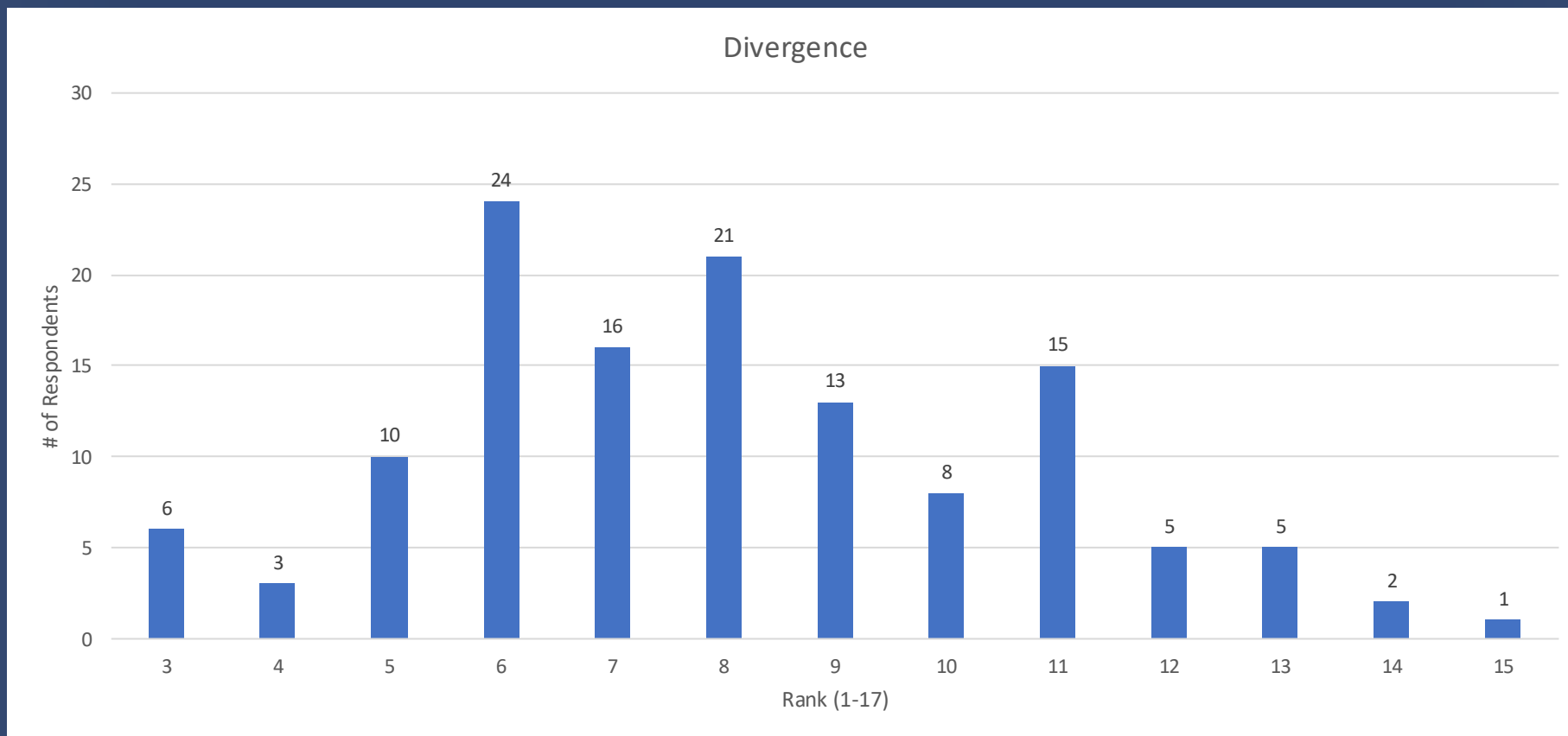
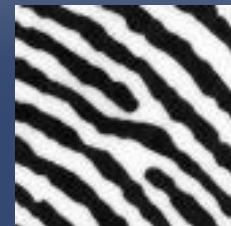
* Any rankings that had 0 respondents were omitted from the visualization.

Spur Ranking (n=129)



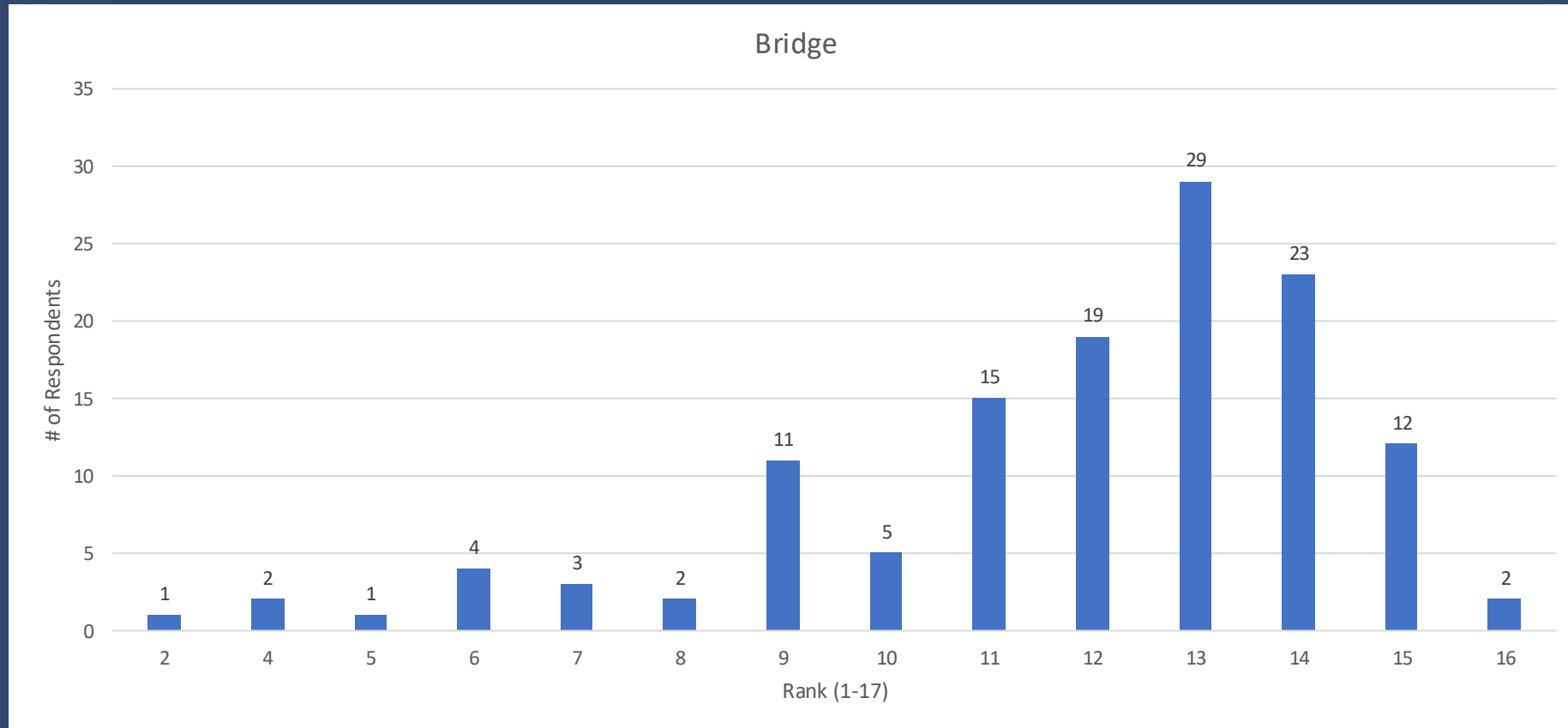
* Any rankings that had 0 respondents were omitted from the visualization.

Divergence Ranking (n=129)



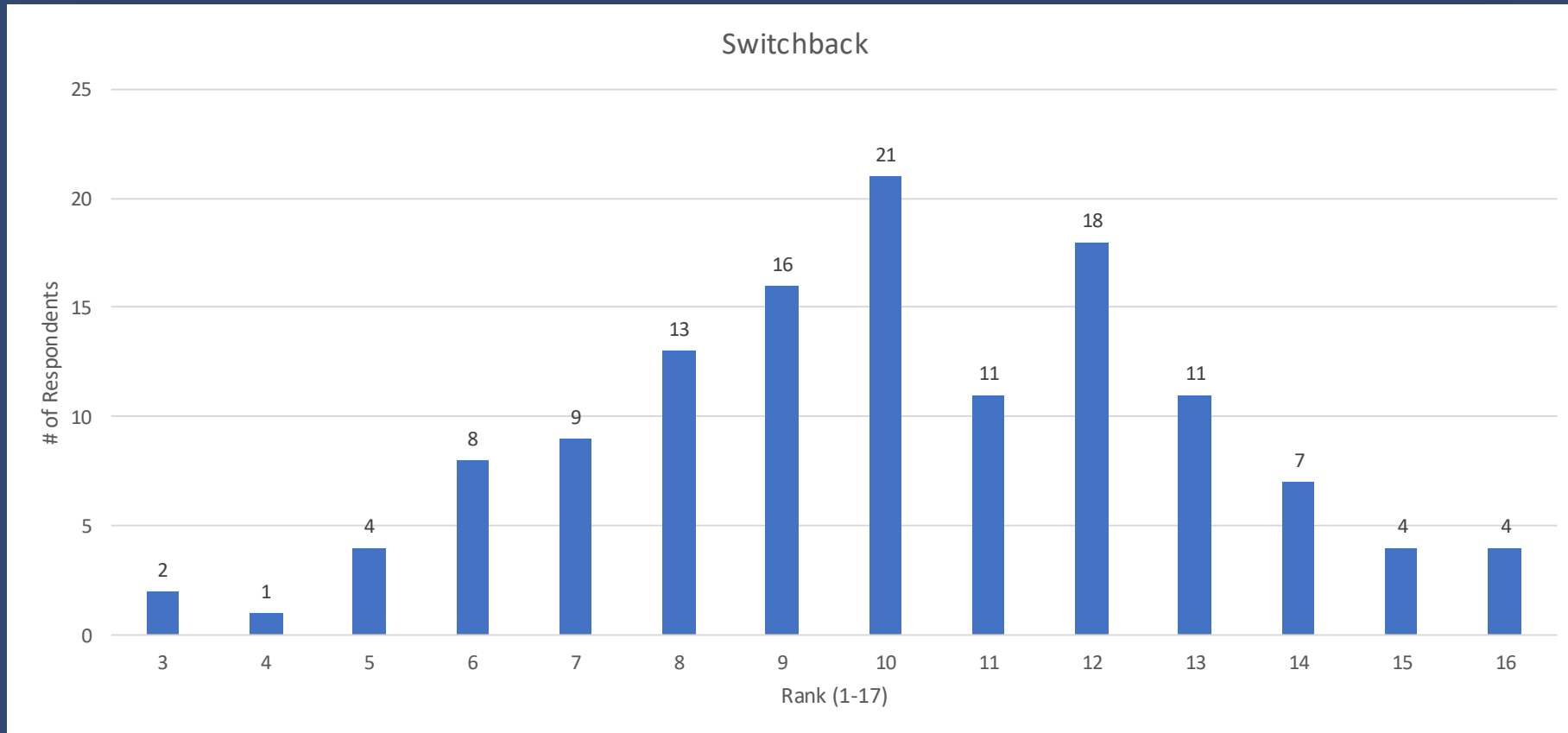
* Any rankings that had 0 respondents were omitted from the visualization.

Bridge Ranking (n=129)



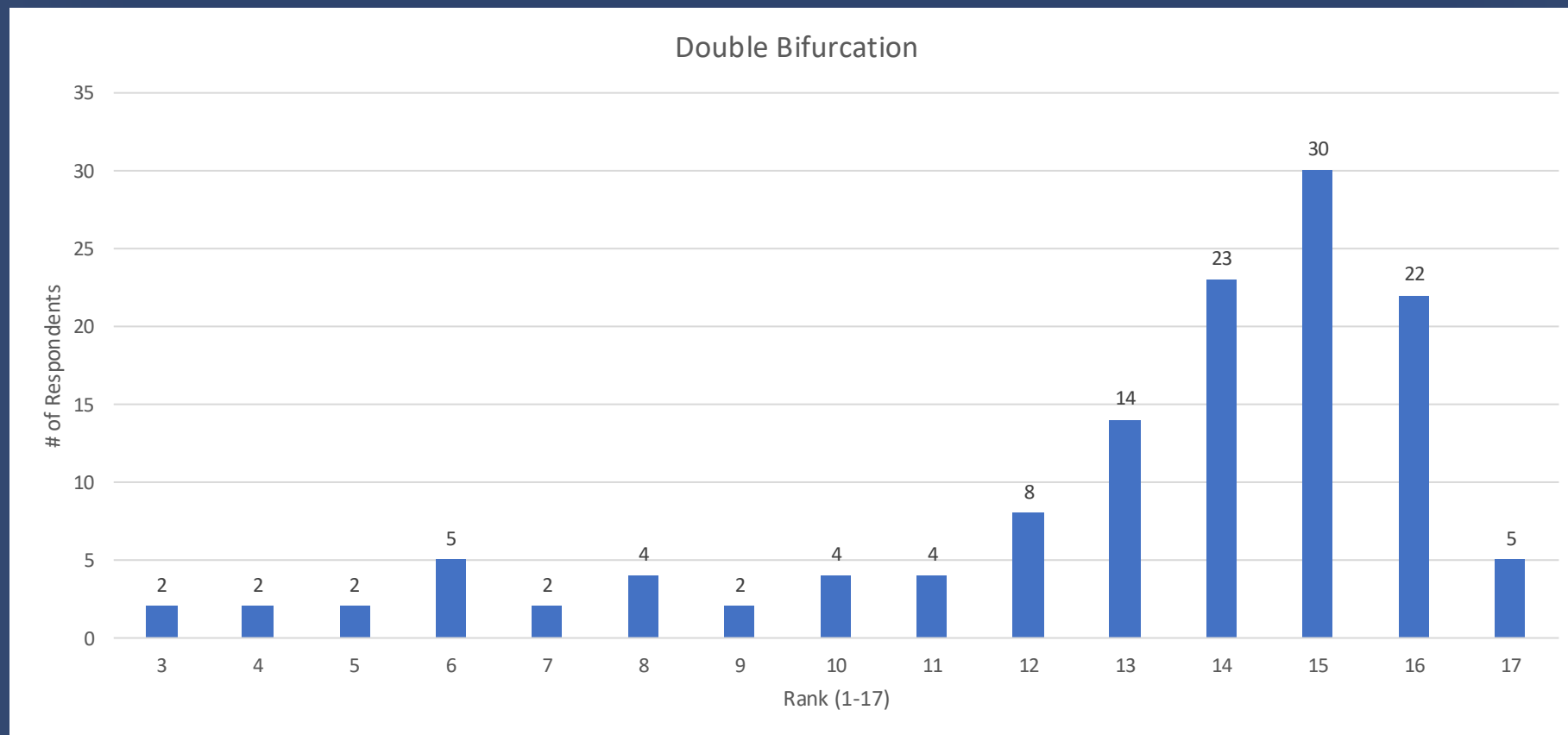
* Any rankings that had 0 respondents were omitted from the visualization.

Switchback Ranking (n=129)



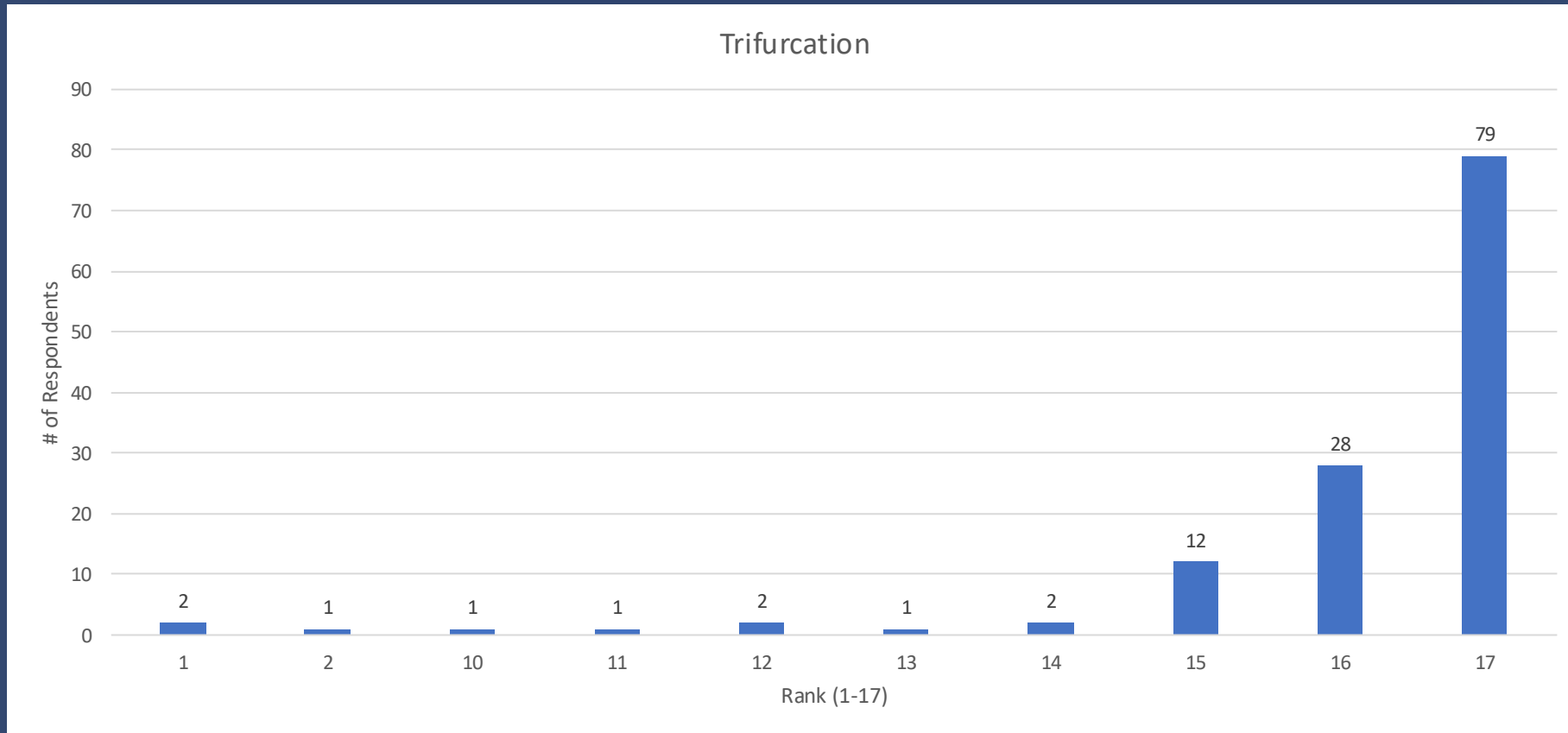
* Any rankings that had 0 respondents were omitted from the visualization.

Double Bifurcation Ranking (n=129)



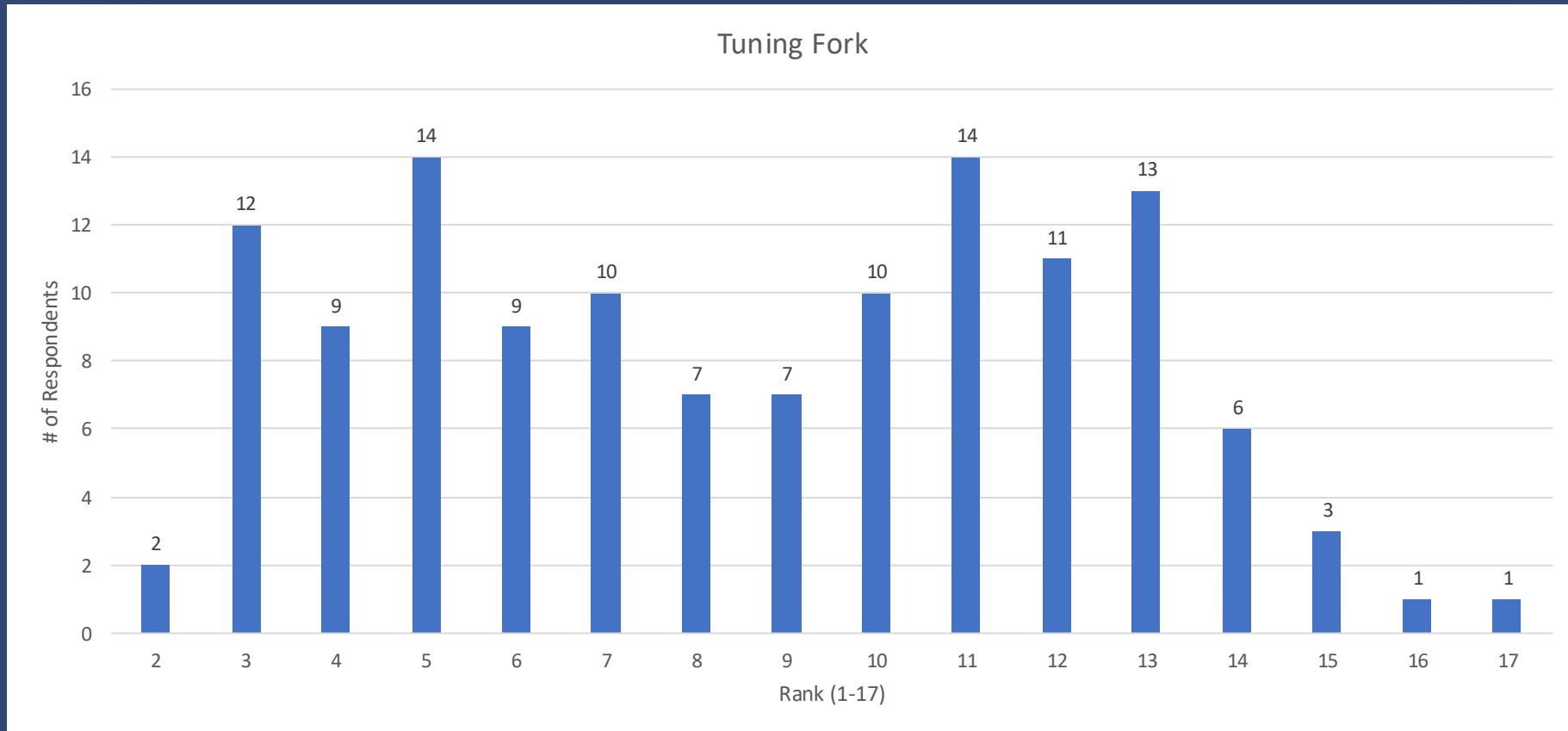
* Any rankings that had 0 respondents were omitted from the visualization.

Trifurcation Ranking (n=129)



* Any rankings that had 0 respondents were omitted from the visualization.

Tuning Fork Ranking (n=129)



* Any rankings that had 0 respondents were omitted from the visualization.

MINUTIAE PAIRS

Question: Considering this pair of minutiae, select the one you believe is more common by clicking on it.

All 136 minutiae pairs (considering the 17 minutiae types) represented. Each respondent received 45 pairs to evaluate.



Pairs Including a Ridge Ending

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
Ridge Ending	40	Short Ridge	0	40
Ridge Ending	38	Spur	0	38
Ridge Ending	29	Switchback	0	29
Ridge Ending	46	Trifurcation	0	46
Ridge Ending	51	Tuning Fork	1	52
Ridge Ending	25	Bifurcation	6	31
Ridge Ending	49	Bridge	0	49
Ridge Ending	39	Crossover	0	39
Ridge Ending	40	Divergence	0	40
Ridge Ending	42	Dock	0	42
Ridge Ending	47	Dot	0	47
Ridge Ending	39	Double Bifurcation	0	39
Ridge Ending	44	Enclosure	0	44
Ridge Ending	49	M	0	49
Ridge Ending	43	Over/Under	0	43
Ridge Ending	45	Ridge Break	1	46

Pairs Including a Bifurcation

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
Bifurcation	50	Bridge	0	50
Bifurcation	42	Ridge Break	3	45
Bifurcation	6	Ridge Ending	25	31
Bifurcation	40	Short Ridge	1	41
Bifurcation	49	Spur	0	49
Bifurcation	43	Switchback	0	43
Bifurcation	44	Trifurcation	0	44
Bifurcation	47	Tuning Fork	1	48
Bifurcation	46	Crossover	0	46
Bifurcation	46	Divergence	2	48
Bifurcation	46	Dock	0	46
Bifurcation	43	Dot	2	45
Bifurcation	35	Double Bifurcation	0	35
Bifurcation	48	Enclosure	1	49
Bifurcation	37	M	0	37
Bifurcation	39	Over/Under	0	39

Pairs Including a Dot

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
Dot	37	Double Bifurcation	1	38
Dot	21	Enclosure	25	46
Dot	44	M	0	44
Dot	27	Over/Under	24	51
Dot	29	Ridge Break	14	43
Dot	0	Ridge Ending	47	47
Dot	8	Short Ridge	41	49
Dot	37	Spur	11	48
Dot	24	Switchback	11	35
Dot	37	Trifurcation	0	37
Dot	21	Tuning Fork	21	42
Dot	2	Bifurcation	43	45
Dot	38	Bridge	3	41
Dot	35	Crossover	5	40
Dot	24	Divergence	19	43
Dot	37	Dock	1	38

Pairs Including a Crossover

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
Crossover	2	Divergence	41	43
Crossover	31	Dock	6	37
Crossover	5	Dot	35	40
Crossover	35	Double Bifurcation	6	41
Crossover	1	Enclosure	35	36
Crossover	41	M	1	42
Crossover	3	Over/Under	44	47
Crossover	7	Ridge Break	30	37
Crossover	0	Ridge Ending	39	39
Crossover	4	Short Ridge	36	40
Crossover	3	Spur	33	36
Crossover	6	Switchback	26	32
Crossover	41	Trifurcation	0	41
Crossover	9	Tuning Fork	35	44
Crossover	0	Bifurcation	46	46
Crossover	29	Bridge	20	49

Pairs Including a Ridge Break

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
Ridge Break	1	Ridge Ending	45	46
Ridge Break	4	Short Ridge	31	35
Ridge Break	16	Spur	20	36
Ridge Break	24	Switchback	20	44
Ridge Break	47	Trifurcation	1	48
Ridge Break	16	Tuning Fork	27	43
Ridge Break	3	Bifurcation	42	45
Ridge Break	36	Bridge	8	44
Ridge Break	30	Crossover	7	37
Ridge Break	15	Divergence	36	51
Ridge Break	40	Dock	1	41
Ridge Break	14	Dot	29	43
Ridge Break	33	Double Bifurcation	5	38
Ridge Break	12	Enclosure	24	36
Ridge Break	34	M	0	34
Ridge Break	11	Over/Under	38	49

Pairs Including an Enclosure

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
Enclosure	36	M	1	37
Enclosure	22	Over/Under	20	42
Enclosure	24	Ridge Break	12	36
Enclosure	0	Ridge Ending	44	44
Enclosure	10	Short Ridge	29	39
Enclosure	34	Spur	9	43
Enclosure	29	Switchback	13	42
Enclosure	48	Trifurcation	0	48
Enclosure	14	Tuning Fork	27	41
Enclosure	1	Bifurcation	48	49
Enclosure	42	Bridge	5	47
Enclosure	35	Crossover	1	36
Enclosure	20	Divergence	21	41
Enclosure	43	Dock	1	44
Enclosure	25	Dot	21	46
Enclosure	37	Double Bifurcation	5	42

Pairs Including a Short Ridge

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
Short Ridge	44	Spur	4	48
Short Ridge	33	Switchback	4	37
Short Ridge	42	Trifurcation	0	42
Short Ridge	23	Tuning Fork	17	40
Short Ridge	1	Bifurcation	40	41
Short Ridge	42	Bridge	1	43
Short Ridge	36	Crossover	4	40
Short Ridge	39	Divergence	9	48
Short Ridge	42	Dock	1	43
Short Ridge	41	Dot	8	49
Short Ridge	42	Double Bifurcation	1	43
Short Ridge	29	Enclosure	10	39
Short Ridge	39	M	0	39
Short Ridge	33	Over/Under	15	48
Short Ridge	31	Ridge Break	4	35
Short Ridge	0	Ridge Ending	40	40

Pairs Including a Dock

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
Dock	1	Dot	37	38
Dock	20	Double Bifurcation	18	38
Dock	1	Enclosure	43	44
Dock	29	M	6	35
Dock	0	Over/Under	44	44
Dock	1	Ridge Break	40	41
Dock	0	Ridge Ending	42	42
Dock	1	Short Ridge	42	43
Dock	1	Spur	36	37
Dock	1	Switchback	48	49
Dock	38	Trifurcation	6	44
Dock	2	Tuning Fork	34	36
Dock	0	Bifurcation	46	46
Dock	14	Bridge	22	36
Dock	6	Crossover	31	37
Dock	1	Divergence	49	50

Pairs Including an M

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
M	0	Over/Under	35	35
M	0	Ridge Break	34	34
M	0	Ridge Ending	49	49
M	0	Short Ridge	39	39
M	1	Spur	42	43
M	1	Switchback	52	53
M	28	Trifurcation	11	39
M	0	Tuning Fork	42	42
M	0	Bifurcation	37	37
M	1	Bridge	45	46
M	1	Crossover	41	42
M	1	Divergence	47	48
M	6	Dock	29	35
M	0	Dot	44	44
M	9	Double Bifurcation	33	42
M	1	Enclosure	36	37

Pairs Including an Over/Under

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
Over/Under	38	Ridge Break	11	49
Over/Under	0	Ridge Ending	43	43
Over/Under	15	Short Ridge	33	48
Over/Under	34	Spur	7	41
Over/Under	37	Switchback	5	42
Over/Under	54	Trifurcation	1	55
Over/Under	17	Tuning Fork	18	35
Over/Under	0	Bifurcation	39	39
Over/Under	37	Bridge	2	39
Over/Under	44	Crossover	3	47
Over/Under	28	Divergence	12	40
Over/Under	44	Dock	0	44
Over/Under	24	Dot	27	51
Over/Under	46	Double Bifurcation	1	47
Over/Under	20	Enclosure	22	42
Over/Under	35	M	0	35

Pairs Including a Spur

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
Spur	23	Switchback	25	48
Spur	49	Trifurcation	1	50
Spur	14	Tuning Fork	27	41
Spur	0	Bifurcation	49	49
Spur	41	Bridge	6	47
Spur	33	Crossover	3	36
Spur	13	Divergence	32	45
Spur	36	Dock	1	37
Spur	11	Dot	37	48
Spur	38	Double Bifurcation	3	41
Spur	9	Enclosure	34	43
Spur	42	M	1	43
Spur	7	Over/Under	34	41
Spur	20	Ridge Break	16	36
Spur	0	Ridge Ending	38	38
Spur	4	Short Ridge	44	48

Pairs Including a Divergence

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
Divergence	49	Dock	1	50
Divergence	19	Dot	24	43
Divergence	34	Double Bifurcation	1	35
Divergence	21	Enclosure	20	41
Divergence	47	M	1	48
Divergence	12	Over/Under	28	40
Divergence	36	Ridge Break	15	51
Divergence	0	Ridge Ending	40	40
Divergence	9	Short Ridge	39	48
Divergence	32	Spur	13	45
Divergence	29	Switchback	13	42
Divergence	47	Trifurcation	1	48
Divergence	24	Tuning Fork	30	54
Divergence	2	Bifurcation	46	48
Divergence	41	Bridge	2	43
Divergence	41	Crossover	2	43

Pairs Including a Bridge

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
Bridge	20	Crossover	29	49
Bridge	2	Divergence	41	43
Bridge	22	Dock	14	36
Bridge	3	Dot	38	41
Bridge	33	Double Bifurcation	9	42
Bridge	5	Enclosure	42	47
Bridge	45	M	1	46
Bridge	2	Over/Under	37	39
Bridge	8	Ridge Break	36	44
Bridge	0	Ridge Ending	49	49
Bridge	1	Short Ridge	42	43
Bridge	6	Spur	41	47
Bridge	8	Switchback	44	52
Bridge	41	Trifurcation	1	42
Bridge	1	Tuning Fork	37	38
Bridge	0	Bifurcation	50	50

Pairs Including a Switchback

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
Switchback	46	Trifurcation	0	46
Switchback	13	Tuning Fork	31	44
Switchback	0	Bifurcation	43	43
Switchback	44	Bridge	8	52
Switchback	26	Crossover	6	32
Switchback	13	Divergence	29	42
Switchback	48	Dock	1	49
Switchback	11	Dot	24	35
Switchback	38	Double Bifurcation	3	41
Switchback	13	Enclosure	29	42
Switchback	52	M	1	53
Switchback	5	Over/Under	37	42
Switchback	20	Ridge Break	24	44
Switchback	0	Ridge Ending	29	29
Switchback	4	Short Ridge	33	37
Switchback	25	Spur	23	48

Pairs Including a Double Bifurcation

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
Double Bifurcation	5	Enclosure	37	42
Double Bifurcation	33	M	9	42
Double Bifurcation	1	Over/Under	46	47
Double Bifurcation	5	Ridge Break	33	38
Double Bifurcation	0	Ridge Ending	39	39
Double Bifurcation	1	Short Ridge	42	43
Double Bifurcation	3	Spur	38	41
Double Bifurcation	3	Switchback	38	41
Double Bifurcation	46	Trifurcation	4	50
Double Bifurcation	2	Tuning Fork	47	49
Double Bifurcation	0	Bifurcation	35	35
Double Bifurcation	9	Bridge	33	42
Double Bifurcation	6	Crossover	35	41
Double Bifurcation	1	Divergence	34	35
Double Bifurcation	18	Dock	20	38
Double Bifurcation	1	Dot	37	38

Pairs Including a Trifurcation

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
Trifurcation	1	Tuning Fork	35	36
Trifurcation	0	Bifurcation	44	44
Trifurcation	1	Bridge	41	42
Trifurcation	0	Crossover	41	41
Trifurcation	1	Divergence	47	48
Trifurcation	6	Dock	38	44
Trifurcation	0	Dot	37	37
Trifurcation	4	Double Bifurcation	46	50
Trifurcation	0	Enclosure	48	48
Trifurcation	11	M	28	39
Trifurcation	1	Over/Under	54	55
Trifurcation	1	Ridge Break	47	48
Trifurcation	0	Ridge Ending	46	46
Trifurcation	0	Short Ridge	42	42
Trifurcation	1	Spur	49	50
Trifurcation	0	Switchback	46	46

Pairs Including a Tuning Fork

Minutiae Type 1	Minutiae Type 1 Count	Minutiae Type 2	Minutiae Type 2 Count	Respondents (n=)
Tuning Fork	1	Bifurcation	47	48
Tuning Fork	37	Bridge	1	38
Tuning Fork	35	Crossover	9	44
Tuning Fork	30	Divergence	24	54
Tuning Fork	34	Dock	2	36
Tuning Fork	21	Dot	21	42
Tuning Fork	47	Double Bifurcation	2	49
Tuning Fork	27	Enclosure	14	41
Tuning Fork	42	M	0	42
Tuning Fork	18	Over/Under	17	35
Tuning Fork	27	Ridge Break	16	43
Tuning Fork	1	Ridge Ending	51	52
Tuning Fork	17	Short Ridge	23	40
Tuning Fork	27	Spur	14	41
Tuning Fork	31	Switchback	13	44
Tuning Fork	35	Trifurcation	1	36

MINUTIA TYPES: PERCENTAGES IN FINGERPRINTS (N=120)

Question: Assign a percentage to each minutia type based on how often you've seen it across all FINGERPRINTS you've examined. Enter whole-number percentages in the boxes below the image. Your percentages must add up to 100%. Think of this as dividing all minutiae you've ever observed into categories. For example, if bifurcations seem very common, you might give them 50%. But if you were to choose 90%, that leaves only 10% to be distributed among the remaining types. Important: Only count ridge endings and bifurcations when they appear on their own. If they appear as part of a combined minutia, they no longer count separately. Example: A spur is counted only as a spur—not as a spur and a ridge ending and a bifurcation.



Fingerprints Percentage Ranking (n=120)

Minutiae Type	Lowest % Assignment	Highest % Assignment	Mean %	Median %	Mode %
Bifurcation	9	66	23	20	20
Bridge	1	5	2	2	1
Crossover	1	10	3	3	2
Divergence	0	15	4	5	5
Dock	0	6	2	1	1
Dot	1	15	5	5	5
Double Bifurcation	0	10	2	1	1
Enclosure	1	10	5	5	5
M	0	5	1	1	1
Over/Under	1	10	5	5	5
Ridge Break	1	20	4	3	2
Ridge Ending	5	50	24	25	20
Short Ridge	1	16	7	6	5
Spur	1	8	3	3	2
Switchback	1	10	4	3	3
Trifurcation	0	5	1	1	1
Tuning Fork	1	15	4	3	1

MINUTIA TYPES: PERCENTAGES IN PALMPRINTS (N=116)

Question: Assign a percentage to each minutia type based on how often you've seen it across all PALMPRINTS you've examined. Enter whole-number percentages in the boxes below the image. Your percentages must add up to 100%. Think of this as dividing all minutiae you've ever observed into categories. For example, if bifurcations seem very common, you might give them 50%. But if you were to choose 90%, that leaves only 10% to be distributed among the remaining types. Important: Only count ridge endings and bifurcations when they appear on their own. If they appear as part of a combined minutia, they no longer count separately. Example: A spur is counted only as a spur—not as a spur and a ridge ending and a bifurcation.



Palmpoint Percentage Ranking (n=116)

Minutiae Type	Lowest % Assignment	Highest % Assignment	Mean %	Median %	Mode %
Bifurcation	1	64	20	20	20
Bridge	0	8	3	2	1
Crossover	0	10	3	3	1
Divergence	0	30	6	5	5
Dock	0	10	2	2	1
Dot	1	20	5	5	5
Double Bifurcation	0	12	2	1	1
Enclosure	0	12	5	5	5
M	0	5	1	1	1
Over/Under	0	30	7	5	5
Ridge Break	0	15	4	4	5
Ridge Ending	1	50	22	20	20
Short Ridge	1	20	8	8	10
Spur	0	8	3	2	1
Switchback	0	10	3	3	1
Trifurcation	0	5	1	1	1
Tuning Fork	0	15	4	4	1

Fingerprint vs. Palmprint Percentage Ranking

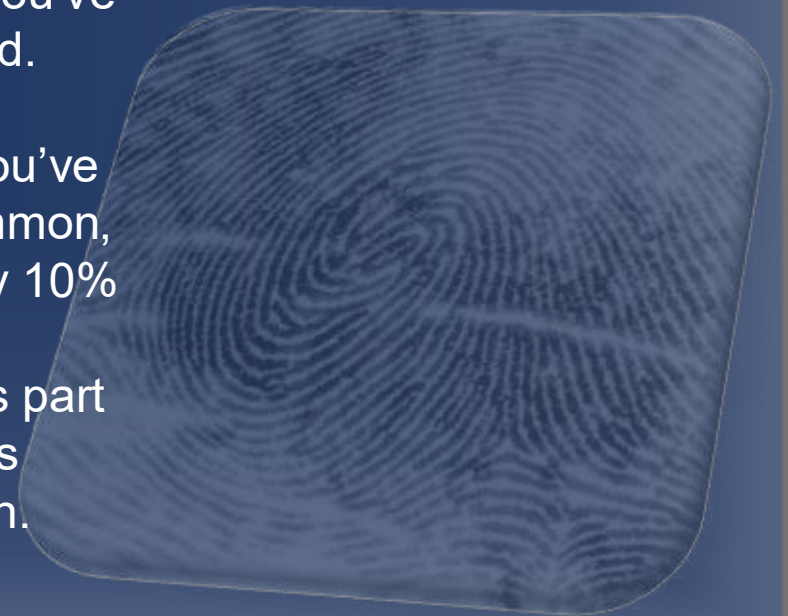
Minutiae Type	Mean Finger %	Mean Palm %	More Prevalent
Bifurcation	23	20	Finger
Bridge	2	3	Palm
Crossover	3	3	Equal
Divergence	4	6	Palm
Dock	2	2	Equal
Dot	5	5	Equal
Double Bifurcation	2	2	Equal
Enclosure	5	5	Equal
M	1	1	Equal
Over/Under	5	7	Palm
Ridge Break	4	4	Equal
Ridge Ending	24	22	Finger
Short Ridge	7	8	Palm
Spur	3	3	Equal
Switchback	4	3	Finger
Trifurcation	1	1	Equal
Tuning Fork	4	4	Equal

None but Bifurcation had a spread of more than 2%



MINUTIA TYPES: PERCENTAGES IN THE INTERDIGITAL PALMPRINT REGION (N=111)

Question: Assign a percentage to each minutia type based on how often you've seen it across all INTERDIGITAL PALMPRINT REGIONS you've examined. Enter whole-number percentages in the boxes below the image. Your percentages must add up to 100%. Think of this as dividing all minutiae you've ever observed into categories. For example, if bifurcations seem very common, you might give them 50%. But if you were to choose 90%, that leaves only 10% to be distributed among the remaining types. Important: Only count ridge endings and bifurcations when they appear on their own. If they appear as part of a combined minutia, they no longer count separately. Example: A spur is counted only as a spur—not as a spur and a ridge ending and a bifurcation.

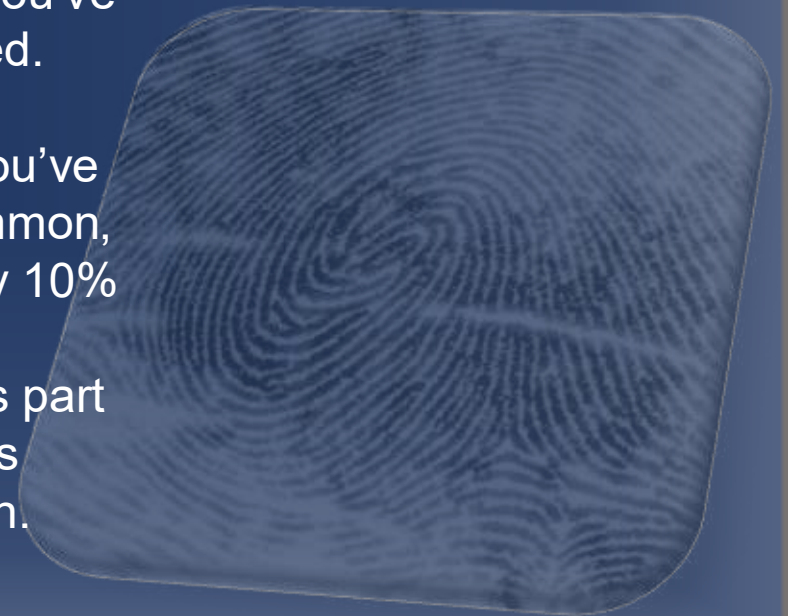


Interdigital Palmprint Region Percentage Ranking (n=111)

Minutiae Type	Lowest % Assignment	Highest % Assignment	Mean %	Median %	Mode %
Bifurcation	5	70	22	20	20
Bridge	0	10	2	1	1
Crossover	0	10	2	2	1
Divergence	0	15	5	5	5
Dock	0	10	2	2	1
Dot	0	16	4	4	5
Double Bifurcation	0	30	3	2	1
Enclosure	1	13	4	3	1
M	0	5	1	1	1
Over/Under	1	18	6	5	5
Ridge Break	0	12	4	3	5
Ridge Ending	5	70	25	24	15
Short Ridge	1	18	7	6	5
Spur	0	10	3	2	1
Switchback	0	15	3	2	2
Trifurcation	0	8	1	1	1
Tuning Fork	0	25	5	4	1

MINUTIA TYPES: PERCENTAGES IN THE HYPOTHENAR PALMPRINT REGION (N=108)

Question: Assign a percentage to each minutia type based on how often you've seen it across all HYPOTHENAR PALMPRINT REGIONS you've examined. Enter whole-number percentages in the boxes below the image. Your percentages must add up to 100%. Think of this as dividing all minutiae you've ever observed into categories. For example, if bifurcations seem very common, you might give them 50%. But if you were to choose 90%, that leaves only 10% to be distributed among the remaining types. Important: Only count ridge endings and bifurcations when they appear on their own. If they appear as part of a combined minutia, they no longer count separately. Example: A spur is counted only as a spur—not as a spur and a ridge ending and a bifurcation.



Hypothenar Palmprint Region Percentage Ranking (n=108)

Minutiae Type	Lowest % Assignment	Highest % Assignment	Mean %	Median %	Mode %
Bifurcation	1	56	19	17	15
Bridge	0	7	2	2	1
Crossover	0	10	3	3	1
Divergence	0	16	6	5	5
Dock	0	8	2	2	1
Dot	0	14	5	5	5
Double Bifurcation	0	25	2	1	1
Enclosure	1	12	4	3	5
M	0	5	1	1	1
Over/Under	1	20	7	7	5
Ridge Break	1	15	4	4	5
Ridge Ending	5	70	25	22	20
Short Ridge	1	20	8	8	10
Spur	0	15	3	3	1
Switchback	0	10	3	3	5
Trifurcation	0	7	1	1	1
Tuning Fork	0	20	4	4	1

Comparison Percentage Ranking Across Zones

Minutiae Type	Mean Finger %	Mean Palm %	Mean Interdig %	Mean Hypo %	TOTAL % Spread
Bifurcation	23	20	22	19	4
Bridge	2	3	2	2	1
Crossover	3	3	2	3	1
Divergence	4	6	5	6	2
Dock	2	2	2	2	0
Dot	5	5	4	5	1
Double Bifurcation	2	2	3	2	1
Enclosure	5	5	4	4	1
M	1	1	1	1	0
Over/Under	5	7	6	7	2
Ridge Break	4	4	4	4	0
Ridge Ending	24	22	25	25	3
Short Ridge	7	8	7	8	1
Spur	3	3	3	3	0
Switchback	4	3	3	3	1
Trifurcation	1	1	1	1	0
Tuning Fork	4	4	5	4	1



What's Next?

Count real samples



Questions?

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