Difference Tests

Can the judge discriminate between two confusable products?

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Definitions

- Sensory discrimination tests, also known as difference tests, are comparative procedures for use in the study of sensory discriminability of similar types of stimuli.

- Can you tell a difference?
- If the difference is obvious?
- Only for confusable difference

Why is this important?

- Strategic ingredient sourcing
- Plant to plant variability
- Shelf life determination
- Formulation matching
- Pilot plant versus production plant
- Ad claims ("bottled beer taste in a can")

Discrimination Tests

- Two general tests:
  - Unspecified (overall difference)
  - Specified (attribute specific difference)
- Alternatives:
  - Signal detection, R-index
  - Ranking

Unspecified (overall difference)

- Is there a difference between products?
  - the nature of the difference is unknown
- Are the two samples perceptibly different?
  - will only know “yes” or “no”
  - will not know “why”

Unspecified (overall difference)

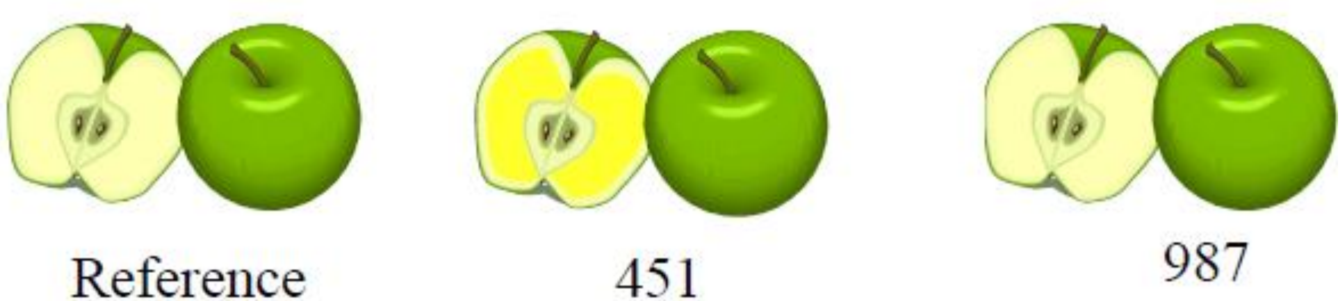
- Duo-trio

  - balanced reference

  - constant reference
- Triangle
- A-not-A
- Tetrad
- Two out of Five

Duo-Trio Test

- A reference sample (R) was followed by two unknowns(A&B), one of which is identical to R



- Which one is the same as the standard?
- One-tailed
- The probability of correct guessing is p=1/2

Duo-Trio Test
(Counterbalancing Orders)

Balanced Reference

A&B as Reference

R_A – AB

R_A – BA

R_B – AB

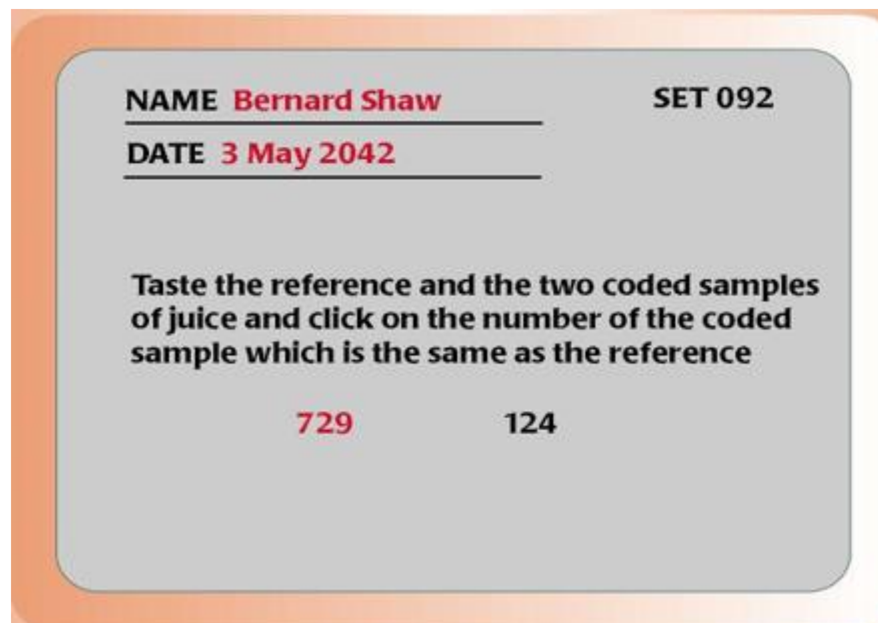
R_B – BA

Constant Reference

A or B as Reference

R_A – AB

R_A – BA



Triangle Test

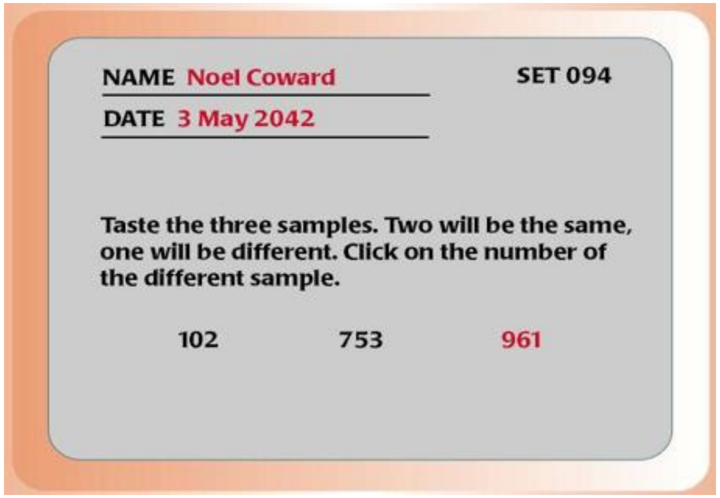
- Two products are the same, one is different (odd sample).

- One sample is different from the other two. Indicate the odd sample.
- One-tailed
- The probability of correct guessing is p=1/3

Triangle Test
(Counterbalancing Orders)

<u>Six orders:</u>

AAB	BBA
ABA	BAB
ABB	BAA

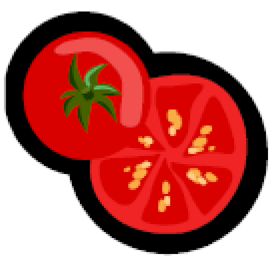


A / Not A Test

- Familiarize subjects with samples ‘A’ and ‘Not a’.
- Present series of products and ask subjects whether they are ‘A’ or ‘Not A’.
- Compare correct and incorrect identifications using the chi-square test.

(Unspecified) Tetrad Test

- Four samples, each two are the same.



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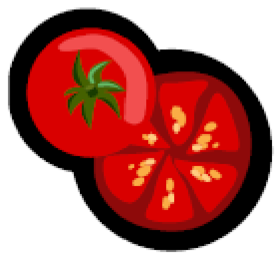

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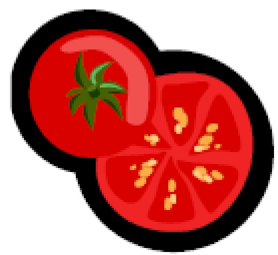

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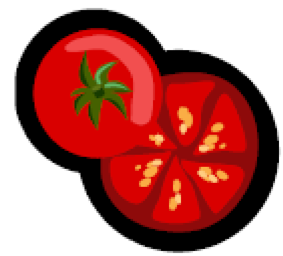

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- sort into two groups of two
- six orders

  AABB BBAA ABAB BABA ABBA BAAB

- probability of correct guessing: p=1/3

Multi Sample Tests

- Sort several samples into two groups
- Two-out-of-Five

  - A,B,A,B,B (10 serving orders)

  - Probability of correct guessing: $p>1/10$

Specified (attribute specific difference)

- Nature of difference specified

  - 2-AFC (2-Alternative forced choice) or Paired comparison

  - 3-AFC

  - N-AFC

Paired Comparison / 2-AFC

DIRECTIONAL:
- Indicate which sample is sweeter, fruitier more sour, more viscous etc

- Judges must understand what you mean by the attribute you specify

What attributes would ordinary Consumers understand?

MORE:

sweet?	bitter?
sour?	salty?
fruity?	viscous, thick?
crunchy, noisy?	darker looking?
spicy?	umami?
well blended?	chocolate?

You may need to give standards

3-Alternative Forced Choice

- A 3-AFC test is a triangle test where the odd sample is the sample with the higher intensity of the two samples being compared



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- one sample is sweeter than the other two. Indicate the sweeter
- have a prior knowledge of the difference

Applications

- Thresholds
- Difference testing

  - when you want to show that people perceive the difference
- Similarity testing

  - when you want to show that people do not perceive the difference

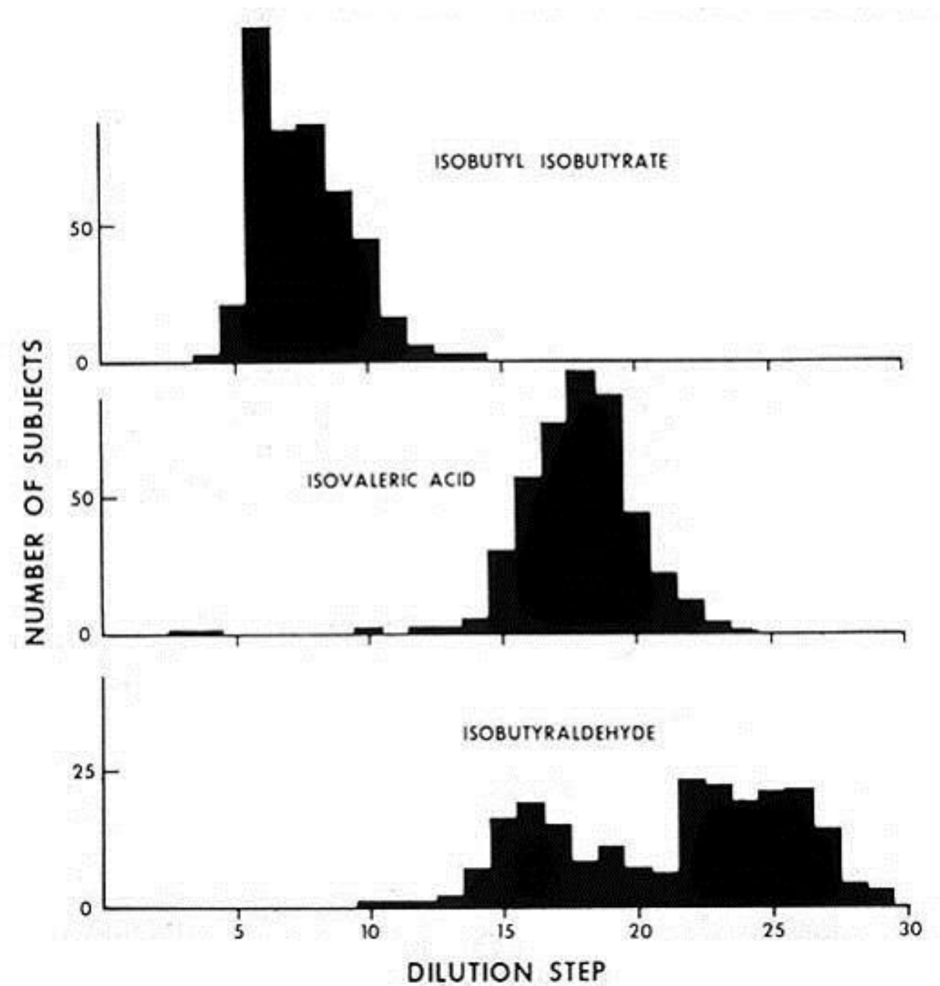
Thresholds

- Use for comparative purpose only (there are no absolute measures)
- Four types:

  - Detection threshold
  - Recognition threshold
  - Difference threshold = just noticeable difference
  - Terminal threshold

Detection Threshold

- Minimum concentration of a stimulus that can be detected



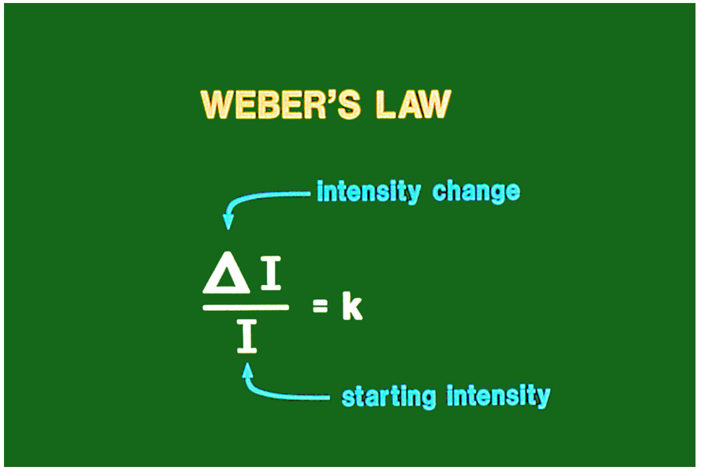
Recognition Threshold

- Minimum concentration of a stimulus that can be recognized
- Prone to response bias

  -In what level could be called “sweet”?

Difference Threshold

- Minimum increase in the concentration of a stimulus that can be detected = just noticeable difference
- A function of the original stimulus concentration
- Weber's law



Terminal Threshold

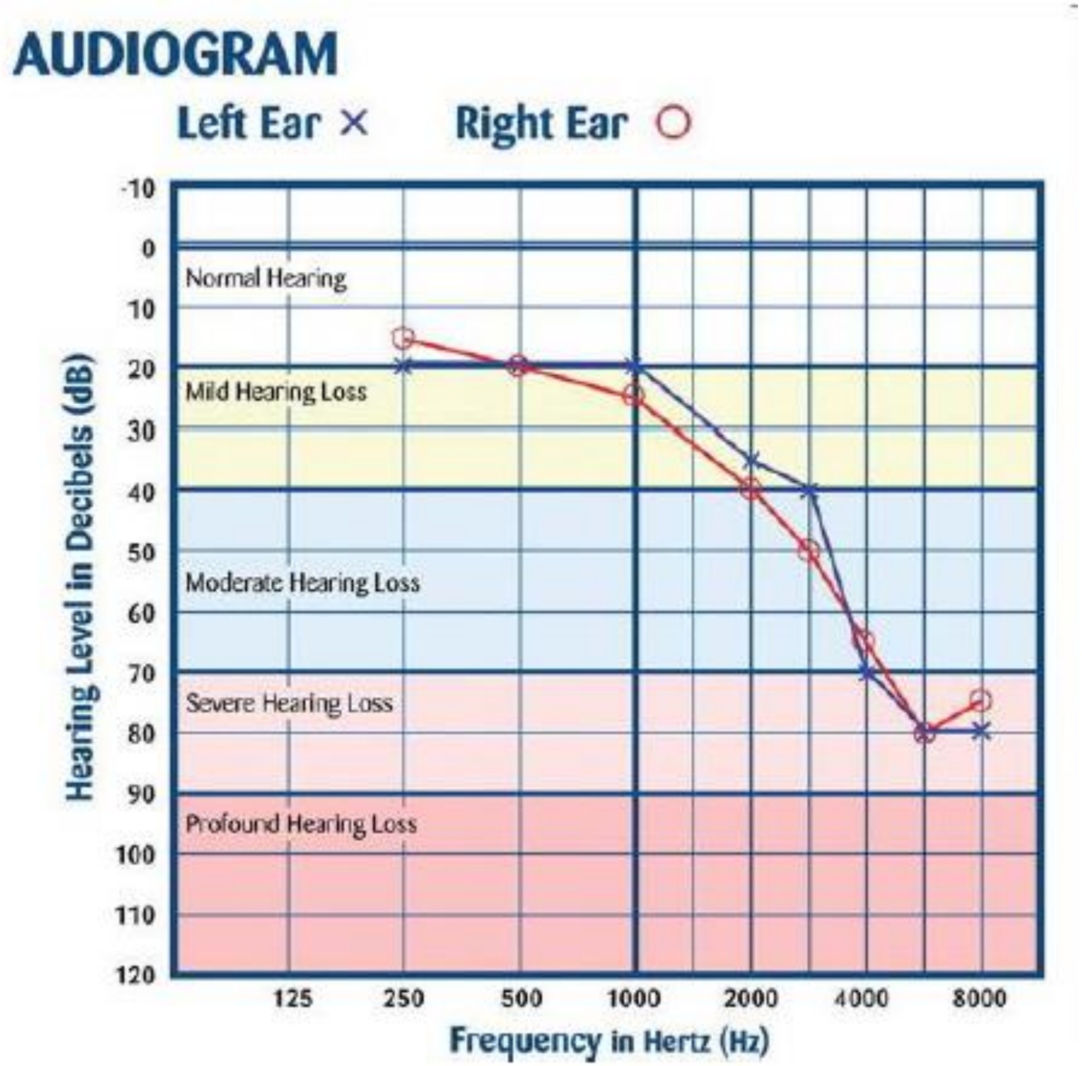
- The concentration of a stimulus above which there is no increase in perceived intensity
- Prone to response bias

Thresholds

Measures based on difference tests

- Methods of limits
  - Ascending method of limits
  - Descending method of limits
  - Staircase method
  - Up-and-down method
- Method of average error
- Frequency method

Thresholds – Up & Down Method



Type I and Type II Errors

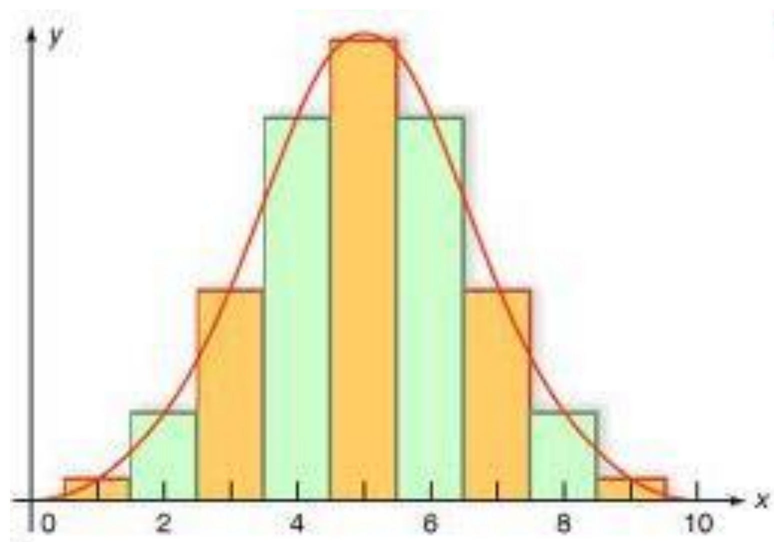
- **A Type I Error** is one we commit if we reject the Null Hypothesis when it is actually true.
- Concluding that two samples are perceptibly different when they are not!
- The risk of committing a Type I error is called **alpha (α)**

Difference Testing

- Purpose is to show that there is a difference between products.
- **Minimize alpha, the risk of a Type I error**, i.e., incorrectly stating that products are different when they are not.

Difference Testing

- Use any of the difference tests described above (specified or unspecified)
- Compare the number of correct answers to tabulated values based on binomial statistics



Analysis of Difference testing

- Binomial distribution

  Use the correct table!

- Chi-squared distribution
- Z-test calculation

○Example:

Triangle test (p=1/3)

- N=35 judges
- 19 correct answer
- significant difference (p<0.01)

Table 2—Minimum numbers of correct judgments to establish significance at various probability levels for the triangle test (one-tailed, $p = 1/3$)[a]

No. of trials (n)	Probability levels						
	0.05	0.04	0.03	0.02	0.01	0.005	0.001
5	4	5	5	5	5	5	
6	5	5	5	5	6	6	
7	5	6	6	6	6	7	7
8	6	6	6	6	7	7	8
9	6	7	7	7	7	8	8
10	7	7	7	7	8	8	9
11	7	7	8	8	8	9	10
12	8	8	8	8	9	9	10
13	8	8	9	9	9	10	11
14	9	9	9	9	10	10	11
15	9	9	10	10	10	11	12
16	9	10	10	10	11	11	12
17	10	10	10	11	11	12	13
18	10	11	11	11	12	12	13
19	11	11	11	12	12	13	14
20	11	11	12	12	13	13	14
21	12	12	12	13	13	14	15
22	12	12	13	13	14	14	15
23	12	13	13	13	14	15	16
24	13	13	13	14	15	15	16
25	13	14	14	14	15	16	17
26	14	14	14	15	15	16	17
27	14	14	15	15	16	17	18
28	15	15	15	16	16	17	18
29	15	15	16	16	17	17	19
30	15	16	16	16	17	18	19
31	16	16	16	17	18	18	20
32	16	16	17	17	18	19	20
33	17	17	17	18	18	19	21
34	17	17	18	18	19	20	21
35	17	18	18	19	19	20	22
36	18	18	18	19	20	20	22
37	18	18	19	19	20	21	22
38	19	19	19	20	21	21	23
39	19	19	20	20	21	22	23
40	19	20	20	21	21	22	24
41	20	20	20	21	22	23	24
42	20	20	21	21	22	23	25
43	20	21	21	22	23	24	26
44	21	21	22	22	23	24	26
45	21	22	22	23	24	24	26
46	22	22	22	23	24	25	27

Z-test

$$z = \frac{(X - np) - 0.5}{\sqrt{npq}}$$

X = number of correct responses
n = total number of responses
p = probability of chance

Triangle test: p = 1/3

Duo-trio & pair tests: p = ½ q = 1 – p

- See Z-table (area under normal prob. curve) to determine probability of choice being made by chance.

Z-test example

– N = 40 subjects

– 21 correct answer

– Z= [(21 – 40*(1/3)) – 0.5]/[SQRT(40*1/3*2/3)]

= [7.66667 – 0.5]/ [SQRT (8.888889)]

= [7.16667]/[2.9814]

= 2.4037 ~ 2.40

Probability of this occurring by chance = 1 – 0.9918 = 0.0082

Normal (z) distribution Entry area is 1-α under normal curve from -∞ to z(1-α)

z	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952

Type I and Type II Errors

- **A Type II Error** is one we commit if we DO NOT reject the Null Hypothesis (i.e. H0: two samples are same) when it is false.
- Concluding that two samples are NOT different when they are perceptibly different!
  - The risk of committing a Type II Error is called **beta (β)**, which is the risk of NOT finding a difference when one actually exists

Similarity Testing Situation

- Use when the test objective is to determine that **no perceivable difference exists between two products** (ingredient or processing change)
- Based on the same tests as in overall difference testing (triangle, duo-trio)
- **Minimize beta, the risk of a Type II error**, i.e., incorrectly stating that samples are similar (i.e. NOT different) when they are actually different.

Similarity Testing Situation

- Power (=1-beta) is critical in similarity testing
- P_d value: the proportion of discriminators
- Compare the number of correct answers to tabulated values based on binomial statistics

(*NOT the same tables as for difference testing)

Critical Values of the Triangle Test for Similarity (Maximum Number Correct) as a Function of N, Beta, and the Proportion Discriminating

Accept the null with 100 (1-beta) confidence if the number of correct choices does not exceed the tabled value for the allowable proportion of discriminators. Redesigned from M. Meligaard, G.V. Civille, and B.T. Carr, Sensory Evaluation Techniques, Copyright 1991, CRC, Boca Raton, FL.

		Proportion Discriminating	
N	Beta	20%	30%
30	.05	—	11
	.10	10	11
33	.05	—	12
	.10	11	13
36	.05	—	13
	.10	12	14
42	.05	—	16
	.10	14	17
48	.05	16	19
	.10	17	20
54	.05	18	22
	.10	20	23
60	.05	21	25
	.10	22	26
72	.05	26	30
	.10	27	32
84	.05	31	36
	.10	32	38
96	.05	36	42
	.10	38	44

Power

- Power is the probability of finding a difference between the two products IF ONE ACTUALLY EXISTS!
- Power

  depends on

  - Chosen Type I error or alpha (usually 5%)
  - Size of difference between samples
  - Number of panelists

Discriminator

- Discriminators are proportions of people (consumers) who can actually distinguish the differences..

  $P_d = 2P_c - 1$ (2-AFC)

  $P_d = 1.5P_c - 0.5$ (triangle)

  - 'small' effect (only 25% can distinguish)
  - 'medium' effect (37.5% can distinguish)
  - 'large' effect (50% can distinguish)

Sample Size Calculations

% Discriminators	Triangle (p=1/3)	Duo-Trio (p=1/2)
50	18	31
40	28	50
30	51	92
20	113	211
10	444	853

Alpha=5%; Power=1-beta=90%

More powerful tests, smaller samples sizes

The Gist Of Difference Test

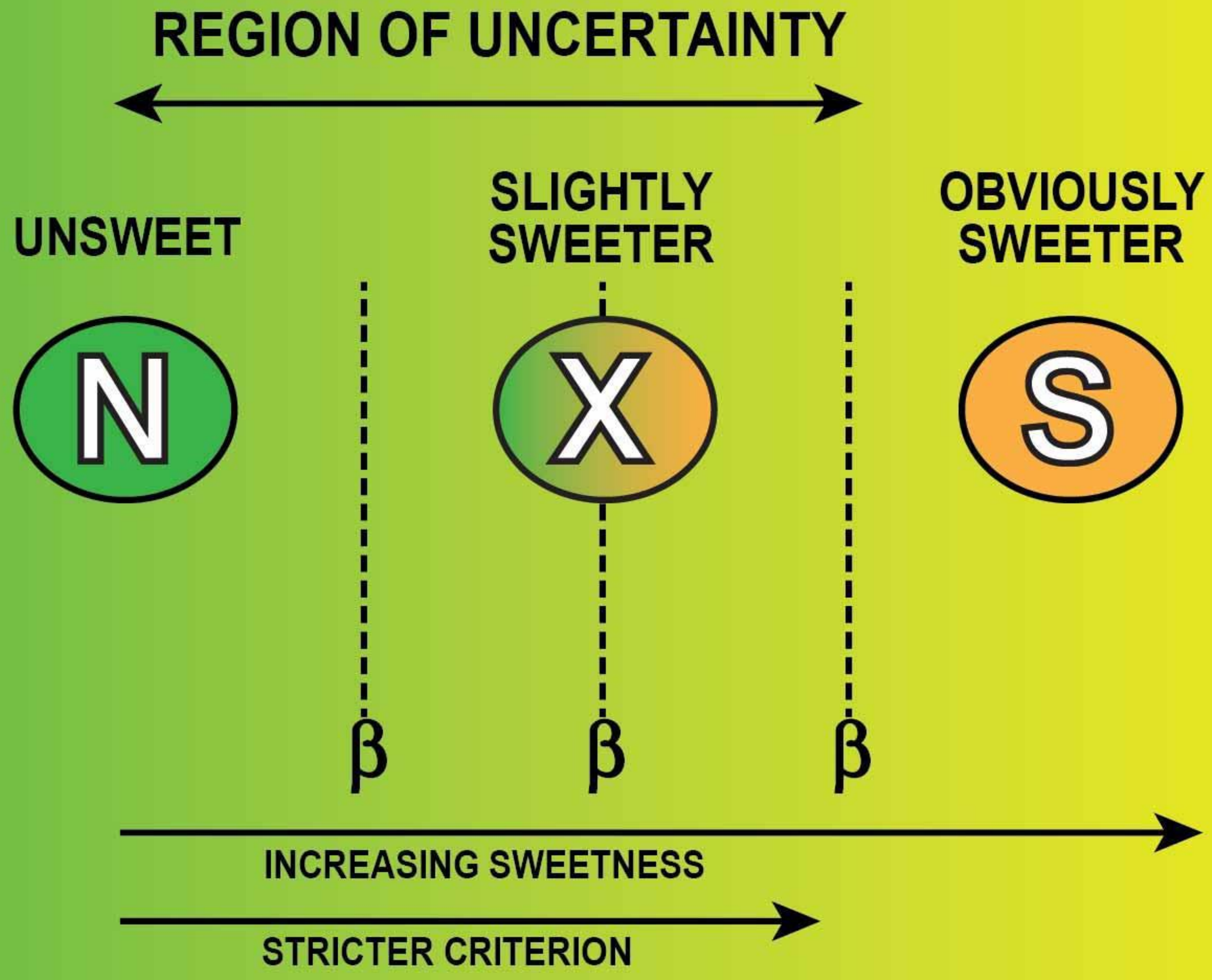
- Difference test is used to find out if two samples are perceptibly different or not
- There are many problems difference tests can and can not solve
- The two main categories of difference tests are overall/unspecified and attribute-specific/specified tests
- The tests are not equal in power and some tests are better suited in some situations

Response Bias

- Response Bias

  - β-criteria

  - τ-criteria


REGION OF UNCERTAINTY
UNSWEET
SLIGHTLY SWEETER
OBVIOUSLY SWEETER
N
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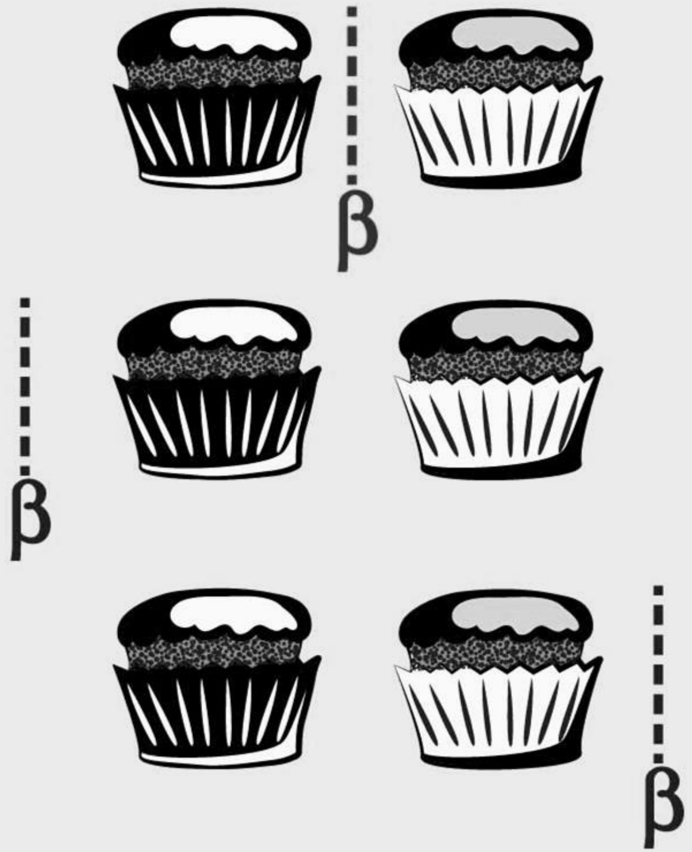
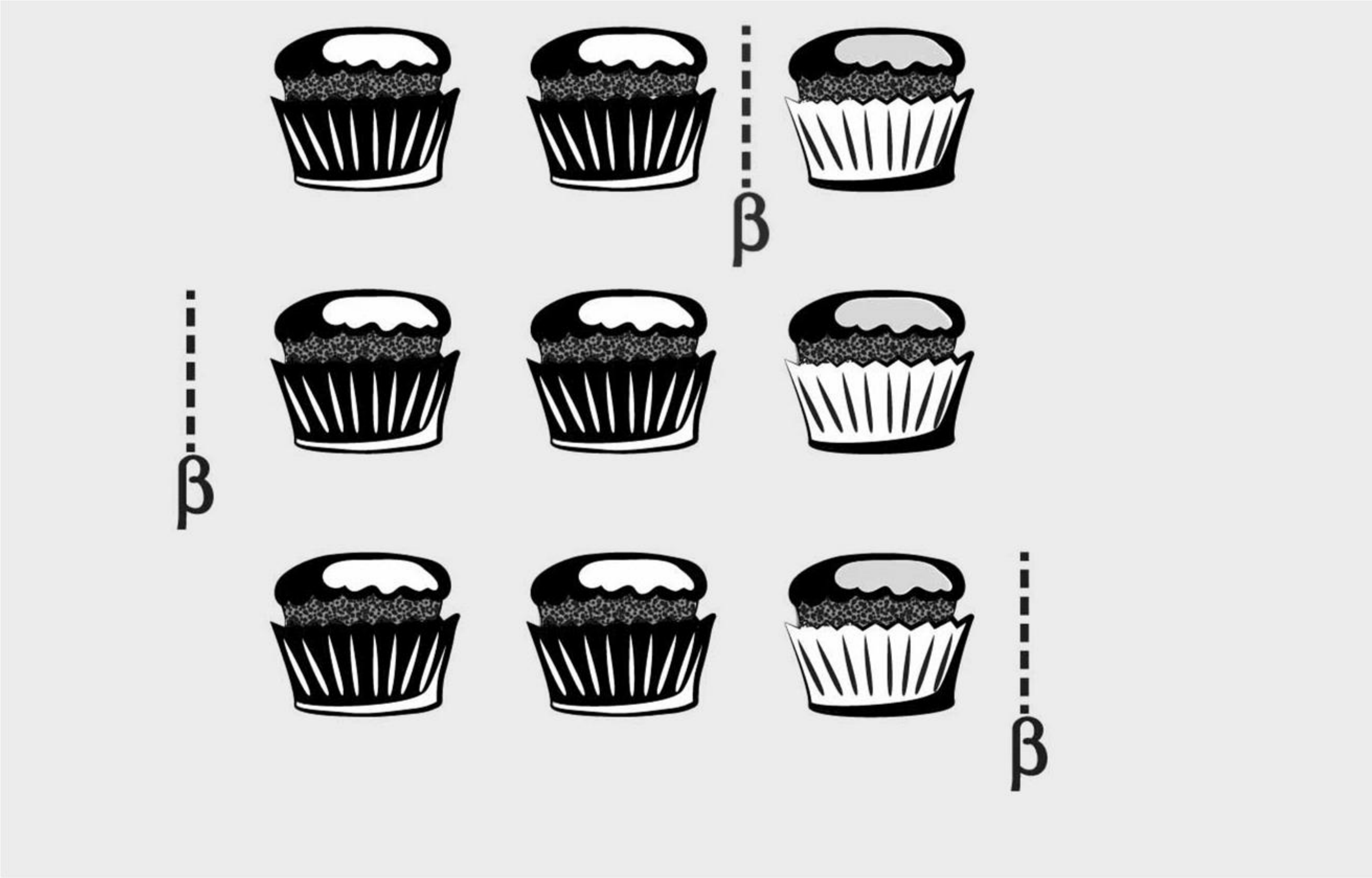
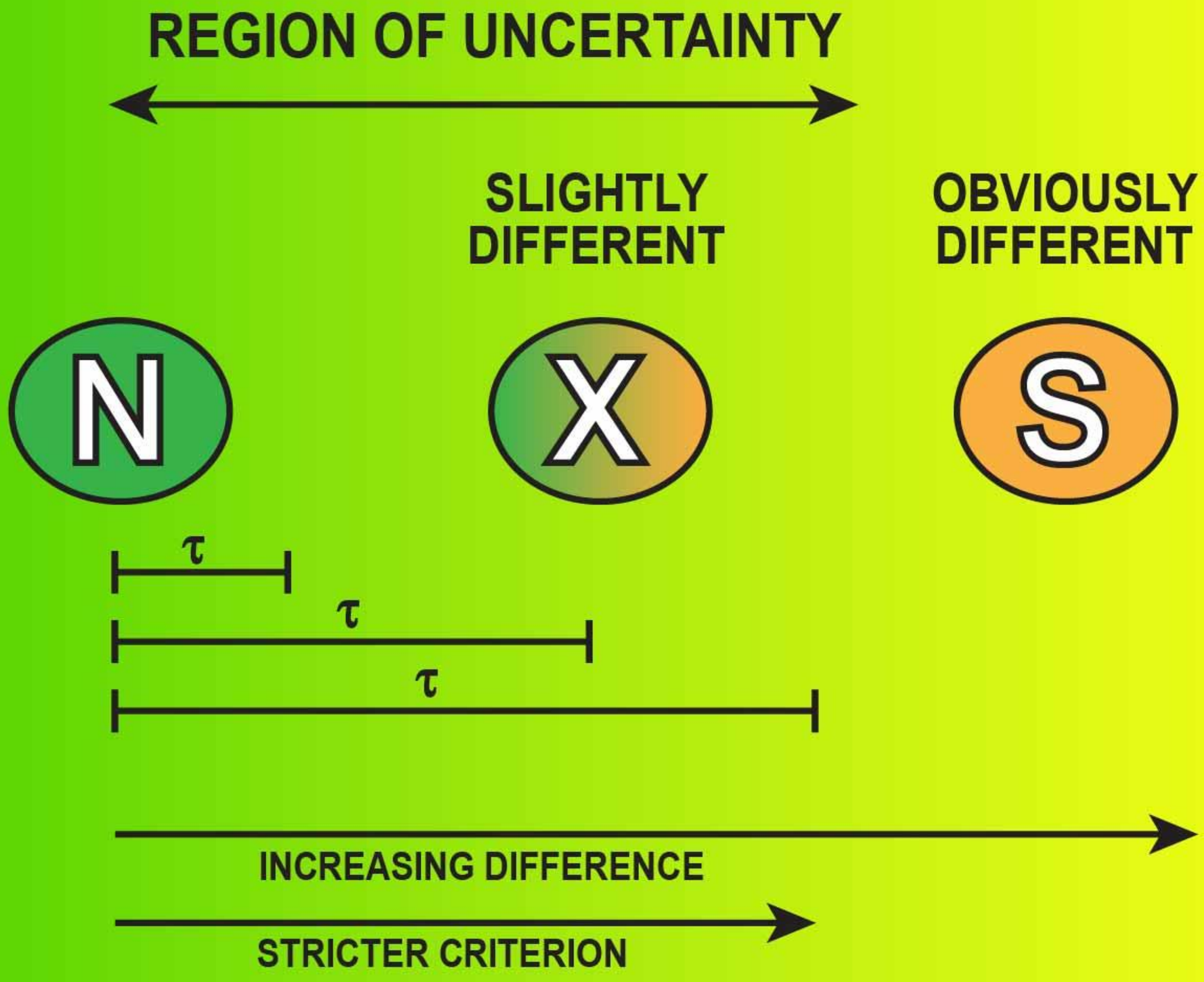
INCREASING SWEETNESS
STRICTER CRITERION

2-Alternative Forced Choice   2-AFC



3-Alternative Forced Choice 3-AFC




REGION OF UNCERTAINTY
SLIGHTLY DIFFERENT
OBVIOUSLY DIFFERENT
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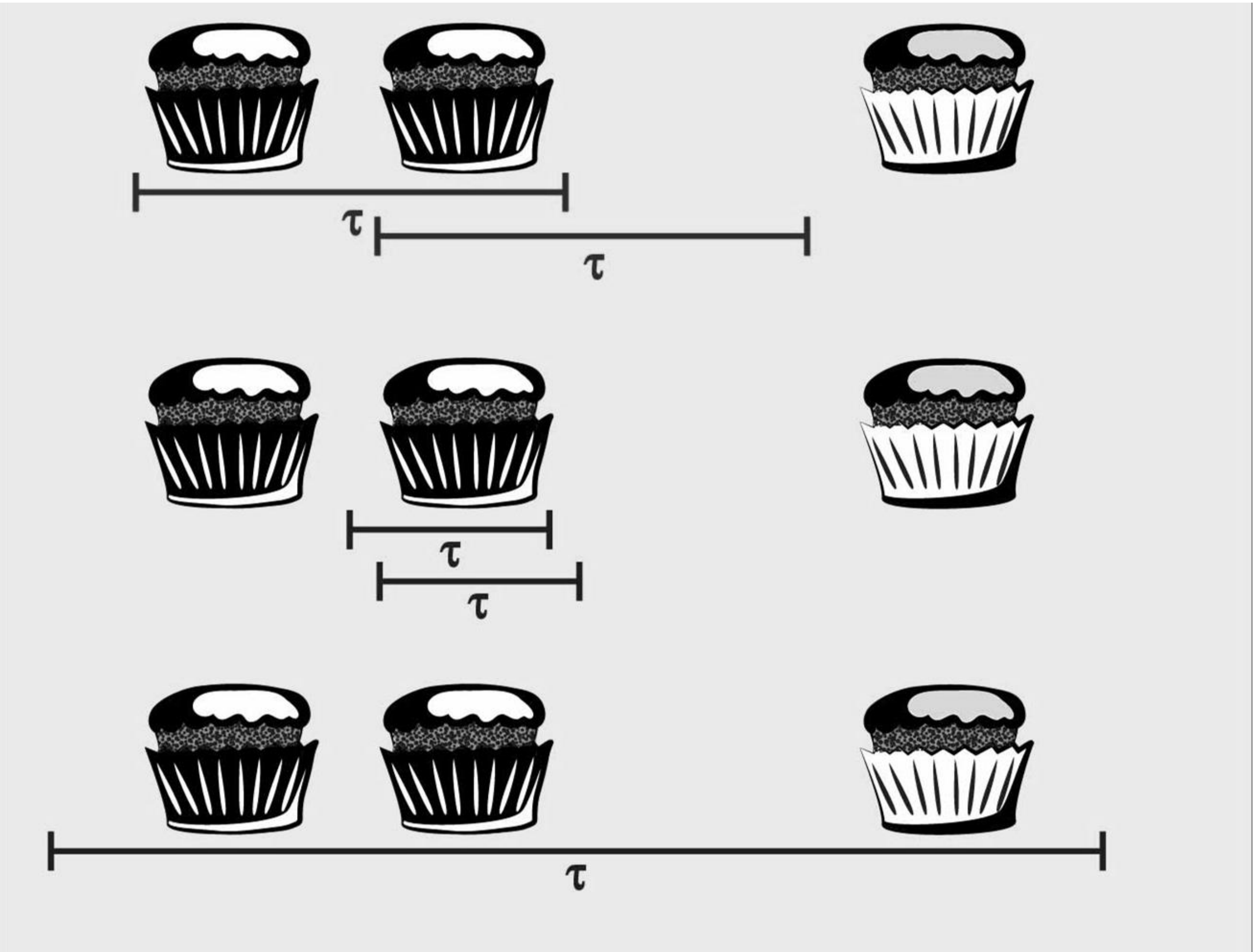
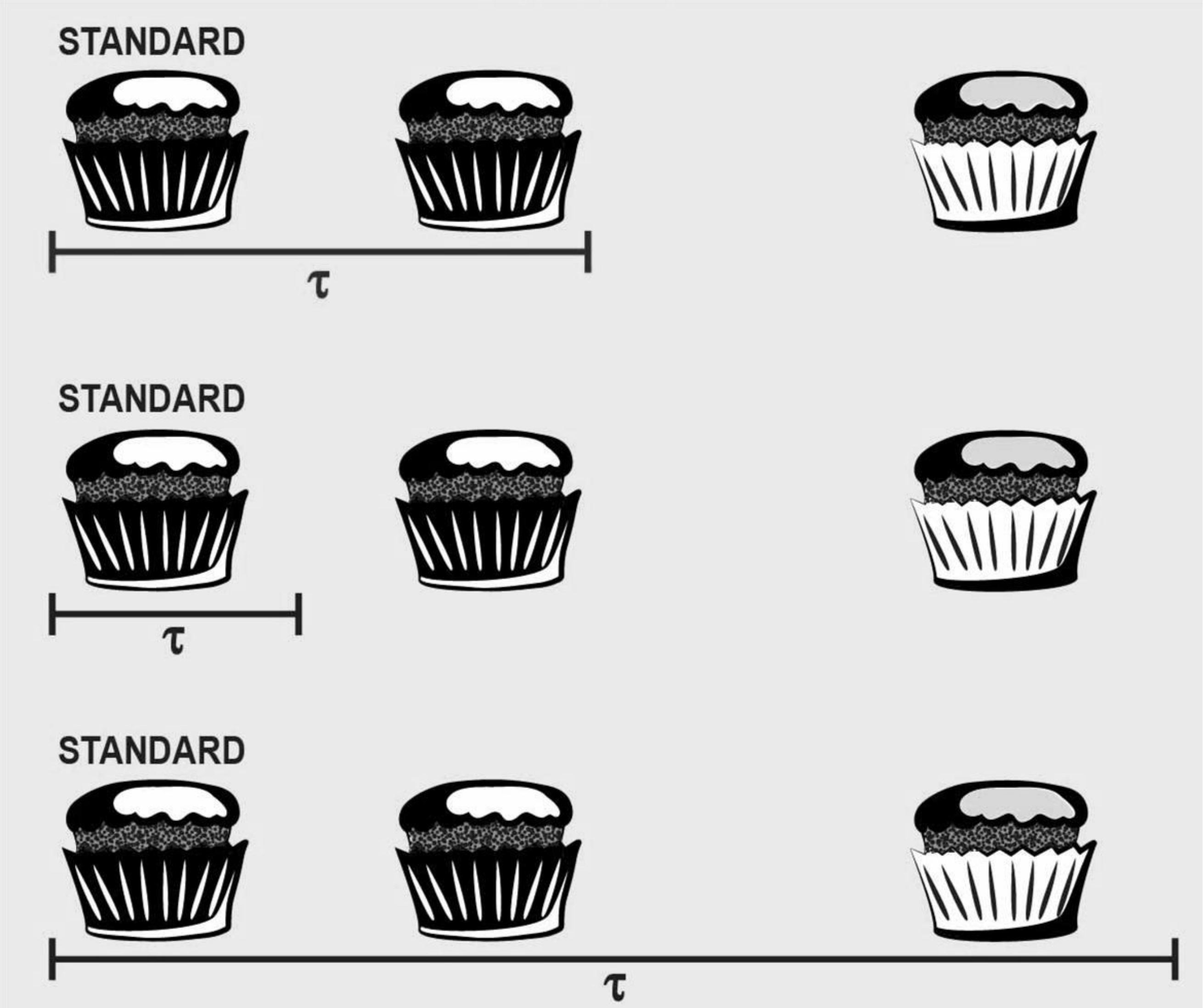
INCREASING DIFFERENCE
STRICTER CRITERION

Triangle



Duo-Trio



How to avoid these response biases?

- **Forced Choice**

  Manipulate beta criterion into appropriate position or tau criterion to appropriate length

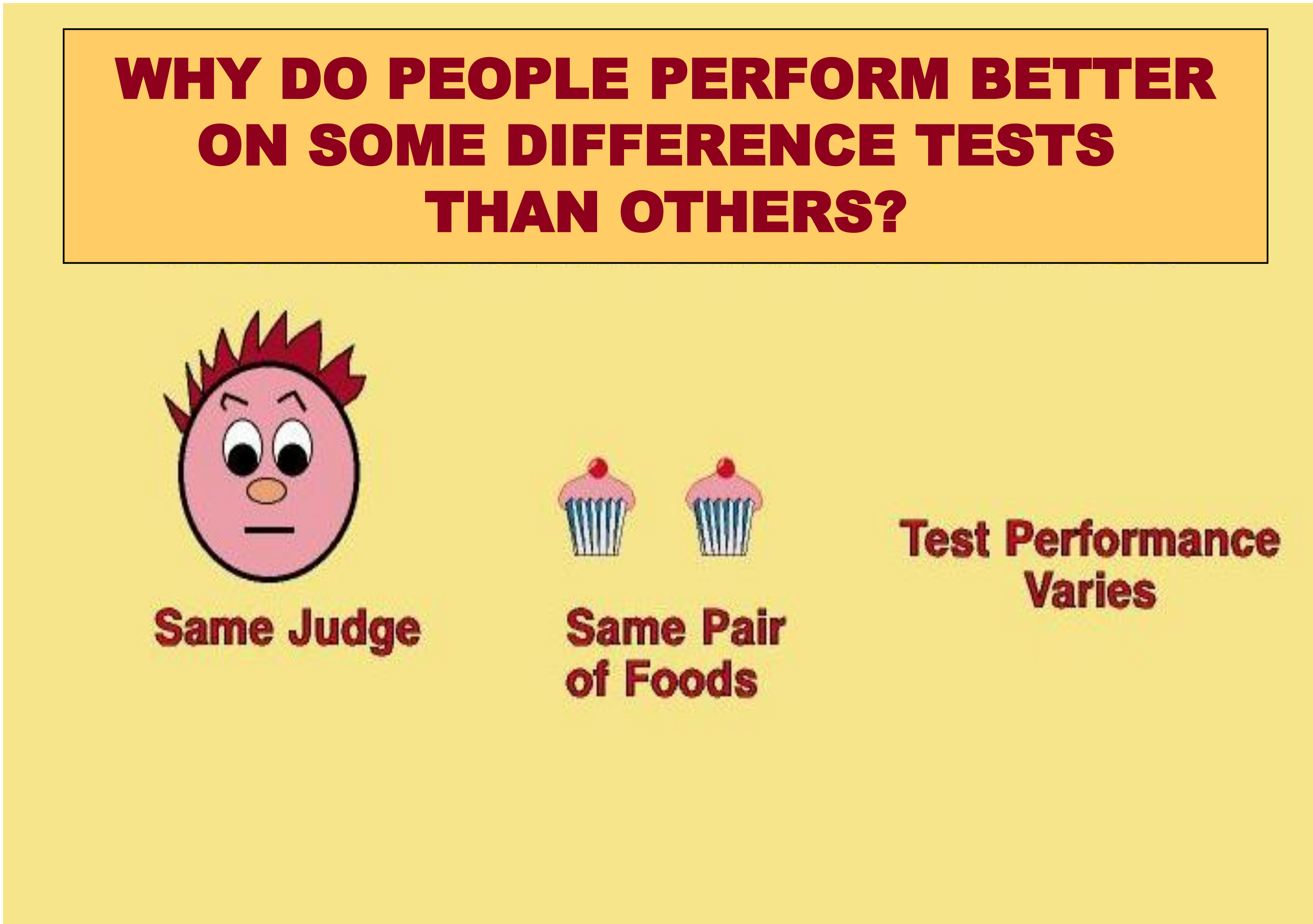
- **Signal Detection**

  Do not manipulate criterion. It is allowed to vary freely. Use signal detection theory to compute d′.

Effects on power of different methods

- Cognitive strategies
- Memory
- Cross-over
- Sequence
- ....

Thurstonian Model



Triangle vs 3-AFC

- **Triangle:**
  - N=33, guessing chance=11
  - 15/33 correct; p=0.1 not significant
- **3-AFC:**
  - N=33, guessing chance=11
  - 23/33 correct; p<0.001 significant

Table G.4.c Probability of X or More Correct Judgments in n Trials (one-tailed, $p = 1/3$)[a]

n \ X	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
5		868	539	210	045	004																							
6		912	649	320	100	018	001																						
7		941	737	429	173	045	007																						
8		961	805	532	259	088	020	003																					
9		974	857	623	350	145	042	008	001																				
10		983	896	701	441	213	077	020	003																				
11		988	925	766	527	289	122	039	009	001																			
12		992	946	819	607	368	178	066	019	004	001																		
13		995	961	861	678	448	241	104	035	009	002																		
14		997	973	895	739	524	310	149	058	017	004	001																	
15		998	981	921	791	596	382	203	088	031	008	002																	
16		998	986	941	834	661	453	263	126	050	016	004	001																
17		999	990	956	870	719	522	326	172	075	027	008	002																
18		999	993	967	898	769	588	391	223	108	043	014	004	001															
19			995	976	921	812	648	457	279	146	065	024	007	002															
20			997	982	940	848	703	521	339	191	092	038	013	004	001														
21			998	987	954	879	751	581	399	240	125	056	021	007	002														
22			998	991	965	904	794	638	460	293	163	079	033	012	003	001													
23			999	993	974	924	831	690	519	349	206	107	048	019	006	002													
24			999	995	980	941	862	737	576	406	254	140	068	028	010	003	001												
25			999	996	985	954	888	778	630	462	304	178	092	042	016	006	002												
26				997	989	964	910	815	679	518	357	220	121	058	025	009	003	001											
27				998	992	972	928	847	725	572	411	266	154	079	036	014	005	002											
28				999	994	979	943	874	765	623	464	314	191	104	050	022	008	003	001										
29				999	996	984	955	897	801	670	517	364	232	133	068	031	013	005	001										
30				999	997	988	965	916	833	714	568	415	276	166	090	043	019	007	002	001									
31					998	991	972	932	861	754	617	466	322	203	115	059	027	011	004	001									
32					998	993	978	946	885	789	662	516	370	243	144	078	038	016	006	002	001								
33					999	995	983	957	905	821	705	565	419	285	177	100	051	023	010	004	001								
34					999	996	987	965	922	849	744	612	468	330	213	126	067	033	014	006	002	001							
35					999	997	990	973	937	873	779	656	516	376	252	155	087	044	020	009	003	001							
36						998	992	978	949	895	810	697	562	422	293	187	109	058	028	012	005	002	001						
37						998	994	963	959	913	838	735	607	469	336	223	135	075	038	018	007	003	001						
38						999	996	987	967	928	863	769	650	515	381	261	164	095	051	025	011	004	002	001					
39						999	997	990	973	941	885	800	689	560	425	301	196	118	066	033	016	007	003	001					
40						999	997	992	979	952	903	829	726	603	470	342	231	144	083	044	021	010	004	001					
41							998	994	983	961	920	854	761	644	515	385	268	173	104	057	029	014	006	002	001				
42							999	995	987	968	933	876	791	683	558	428	307	205	127	073	038	019	008	003	001				
43							999	996	990	974	945	895	820	719	600	471	347	239	153	091	050	025	012	005	002	001			
44							999	997	992	980	955	912	845	753	639	514	389	275	182	111	063	033	016	007	003	001			
45							999	998	994	984	963	926	867	783	677	556	430	313	213	135	079	043	022	010	004	002	001		
46								998	995	987	970	938	887	811	713	596	472	352	246	161	098	055	029	014	006	003	001		
47								999	996	990	976	949	904	836	745	635	514	392	282	189	119	070	038	019	009	004	002	001	
48								999	997	992	980	958	919	859	776	672	554	433	318	220	142	086	048	025	012	006	002	001	
49								999	998	994	984	965	932	879	803	706	593	473	356	253	168	105	061	033	017	008	003	001	
50								999	998	995	987	972	943	896	829	739	631	513	395	287	196	126	076	042	022	011	005	002	001

15/33 p = 0.1
23/33 p < 0.001

Duo-Trio vs 2-AFC

- **Duo-trio**:
  - N=33, guessing chance=16.5 16 or 17
  - 20/33 correct; $p=0.148$ not significant
- **2-AFC:**
  - N=33, guessing chance=16.5 16 or 17
  - 26/33 correct; $p<0.002$ significant

Table G.4.a Probability of X or More Correct Judgments in n Trials (one-tailed, $p = \frac{1}{2}$)[a]

n \ X	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
5		968	812	500	188	031																															
6		984	891	656	344	109	016																														
7		992	938	773	500	227	062	008																													
8		996	965	855	637	363	145	035	004																												
9		998	980	910	746	500	254	090	020	002																											
10		999	989	945	828	623	377	172	055	011	001																										
11			994	967	887	726	500	274	113	033	006																										
12			997	981	927	806	613	387	194	073	019	003																									
13			998	989	954	867	709	500	291	133	046	011	002																								
14			999	994	971	910	788	605	395	212	090	029	006	001																							
15				996	982	941	849	696	500	304	151	059	018	004																							
16				998	989	962	895	773	598	402	227	105	038	011	002																						
17				999	994	975	928	834	685	500	315	166	072	025	006	001																					
18				999	996	985	952	881	760	593	407	240	119	048	015	004	001																				
19					998	990	968	916	820	676	500	324	180	084	032	010	002																				
20					999	994	979	942	868	748	588	412	252	132	058	021	006	001																			
21					999	996	987	961	905	808	668	500	332	192	095	039	013	004	001																		
22						998	992	974	933	857	738	584	416	262	143	067	026	008	002																		
23						999	995	983	953	895	798	661	500	339	202	105	047	017	005	001																	
24						999	997	989	968	924	846	729	581	419	271	154	076	032	011	003	001																
25							998	993	978	946	885	788	655	500	345	212	015	054	022	007	002																
26							999	995	986	962	916	837	721	577	423	279	163	084	038	014	005	001															
27							999	997	990	974	939	876	779	649	500	351	221	124	061	026	010	003	001														
28								998	994	982	956	908	828	714	575	425	286	172	092	044	018	006	002														
29								999	996	988	969	932	868	771	644	500	356	229	132	068	031	012	004	001													
30								999	997	992	979	951	900	819	708	572	428	292	181	100	049	021	008	003	001												
31									998	995	985	965	925	859	763	640	500	360	237	141	075	035	015	005	002												
32									999	997	990	975	945	892	811	702	570	430	298	189	108	055	025	010	004	001											
33									999	998	993	982	960	919	852	757	636	500	364	243	148	081	040	018	007	002											
34										[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]										
35										999	997	992	980	955	912	845	750	632	500	368	250	155	088	045	020	008	003	001									
36										999	998	994	986	967	934	879	797	691	566	434	309	203	121	066	033	014	006	002	001								
37											999	996	990	976	951	906	838	744	629	500	371	256	162	094	049	024	010	004	001								
38											999	997	993	983	964	928	872	791	686	564	436	314	209	128	072	036	017	007	003	001							
39											999	998	995	988	973	946	900	832	739	625	500	375	261	168	100	054	027	012	005	002	001						
40												999	997	992	981	960	923	866	785	682	563	437	318	215	134	077	040	019	008	003	001						
41												999	998	994	986	970	941	894	826	734	622	500	378	266	174	106	059	030	014	006	003	001					
42													999	996	990	978	956	918	860	780	678	561	439	322	220	140	082	044	022	010	004	001					
43													999	997	993	984	967	937	889	820	729	620	500	380	271	180	111	063	033	016	007	003	001				
44													999	998	995	989	976	952	913	854	774	674	560	440	326	226	146	087	048	024	011	005	002	001			
45														999	997	992	982	964	932	884	814	724	617	500	383	276	186	116	068	036	018	008	003	001			
46														999	998	994	987	973	948	908	849	769	671	558	442	329	231	151	092	052	027	013	006	002	001		
47														999	998	996	991	980	961	928	879	809	720	615	500	385	280	191	121	072	039	020	009	004	002	001	
48															999	997	993	985	970	944	903	844	765	667	557	443	333	235	156	097	056	030	015	007	003	001	
49															999	998	995	989	978	957	924	874	804	716	612	500	388	284	196	126	076	043	022	012	005	002	001
50																999	997	992	984	968	941	899	839	760	664	556	444	336	240	161	101	059	032	016	008	003	001

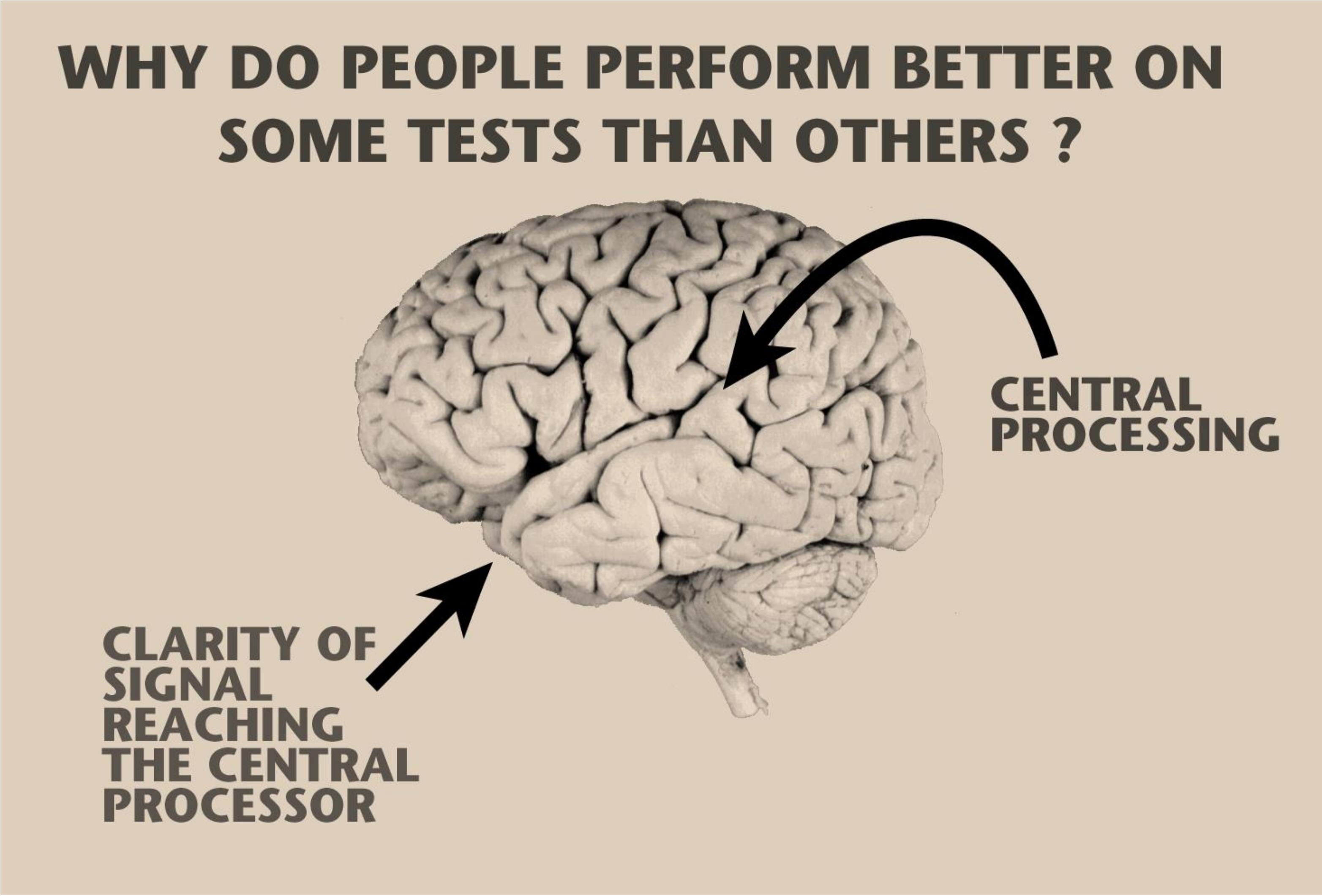
[a]Initial decimal point has been omitted.

Source: E. B. Roessler et al., *Journal of Food Science*, 1978, *43*, 940-947.

20/33 $p = 0.148$

26/33 $p < 0.002$

Why?

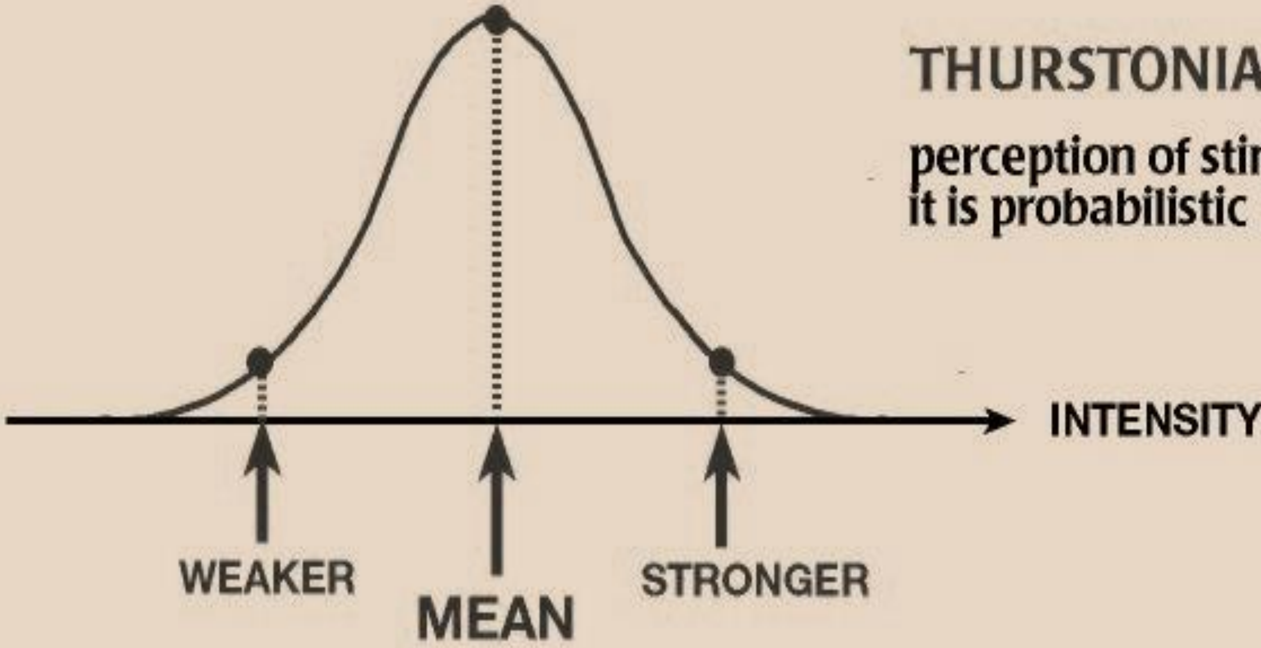

WHY DO PEOPLE PERFORM BETTER ON SOME TESTS THAN OTHERS ?
CENTRAL PROCESSING
CLARITY OF SIGNAL REACHING THE CENTRAL PROCESSOR

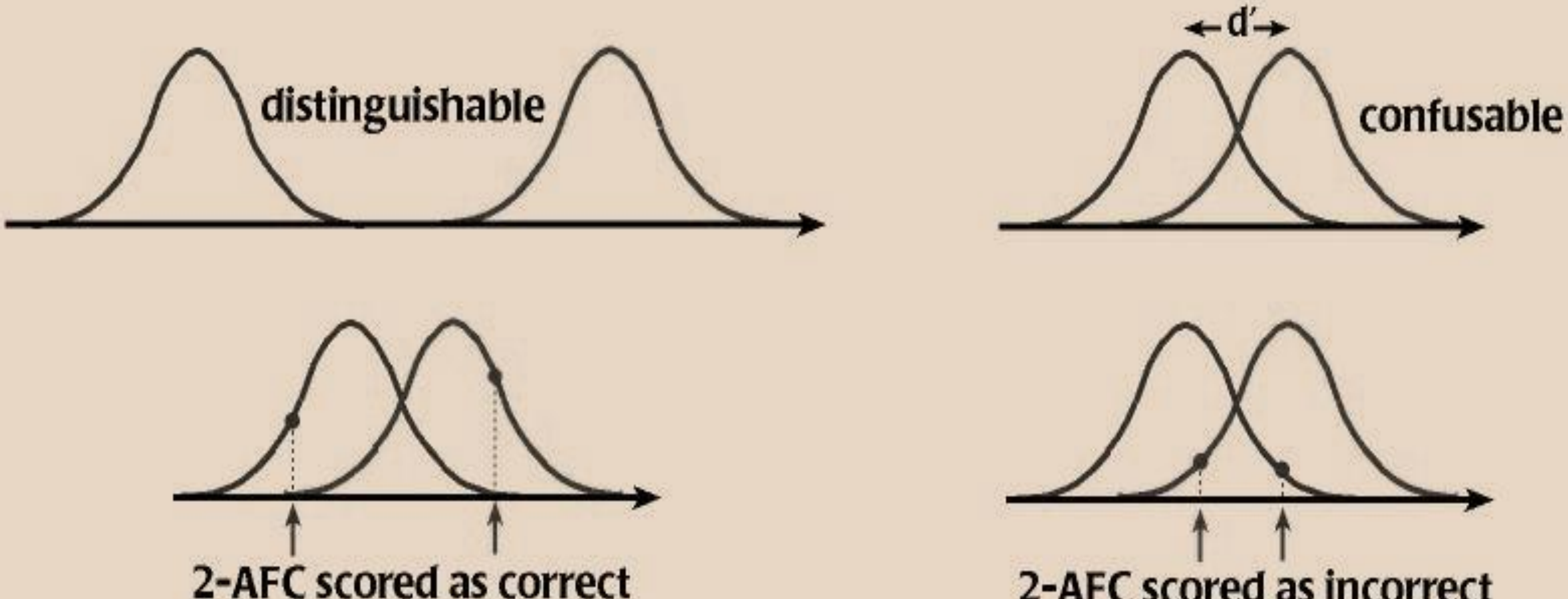
Thurstonian Modeling

Louis Leon Thurstone 1887-1955

THURSTONIAN MODELS

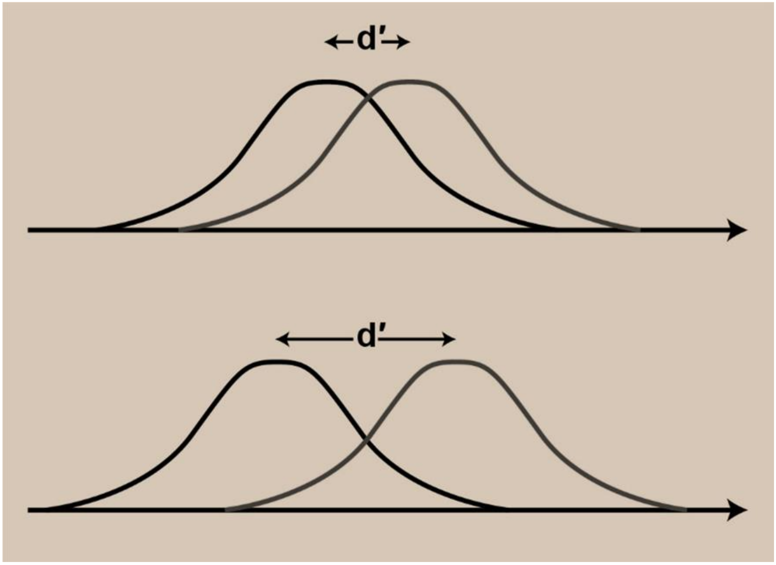
perception of stimulus varies in intensity;
it is probabilistic

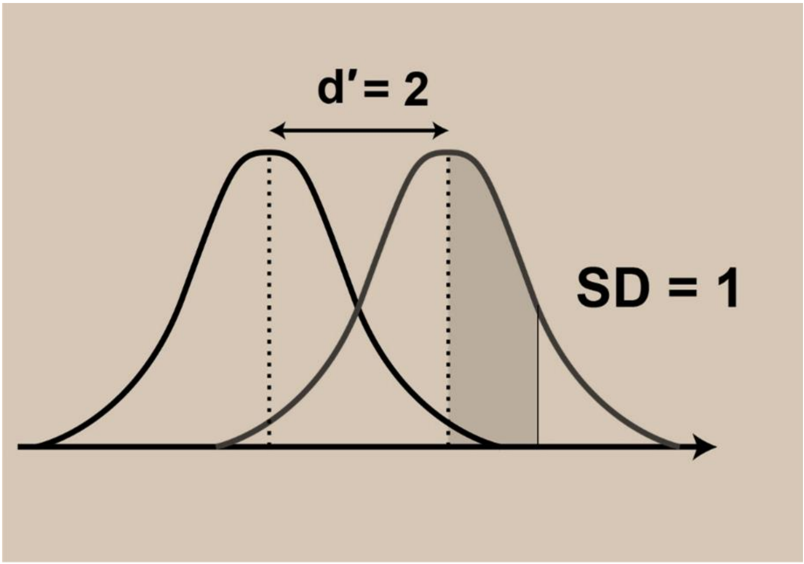




d-prime

The distance between the means of the two sensory distributions, measured in standard deviations, is called **d'**





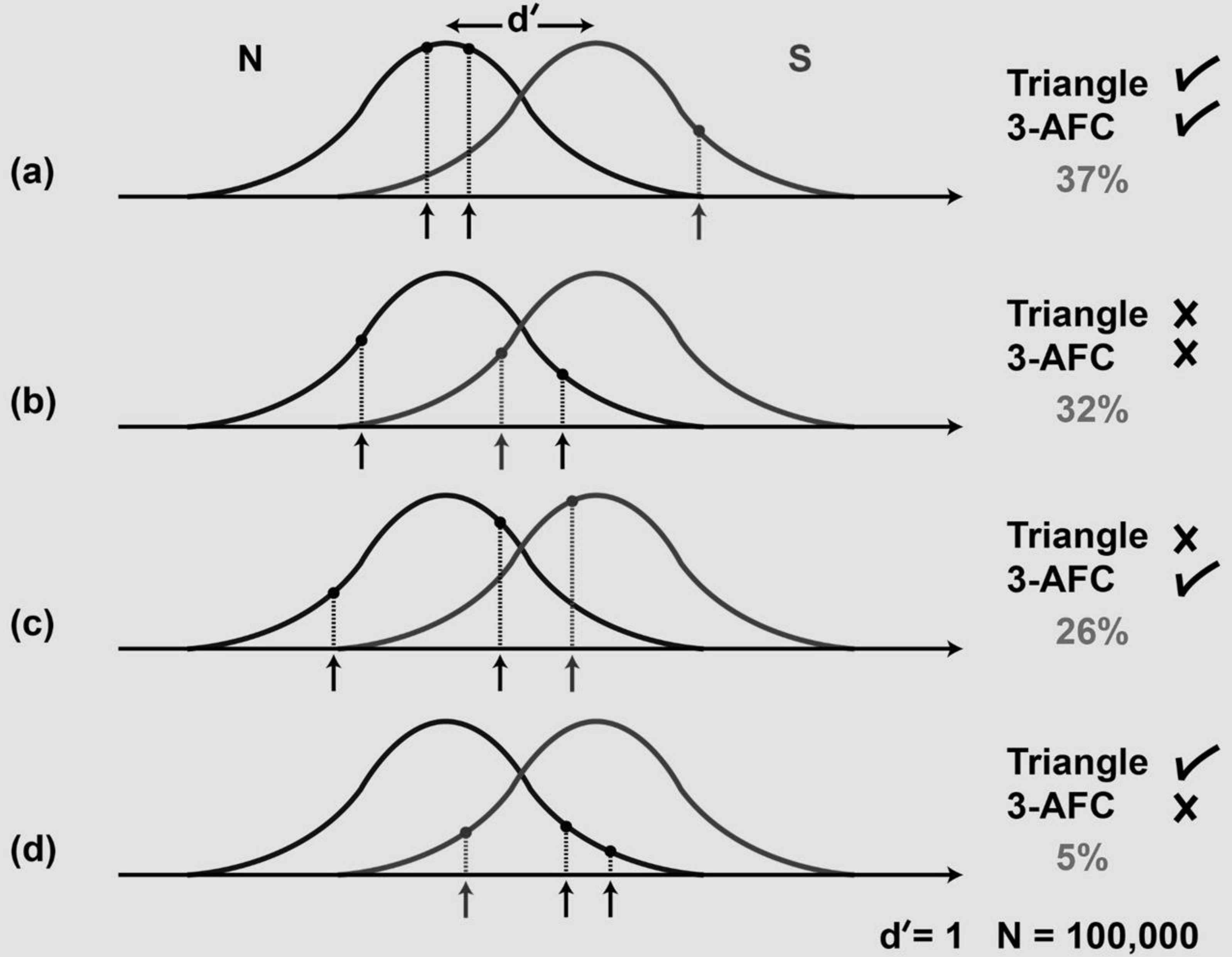
The paradox of discriminatory non-discriminators

- Non-discriminators had different judgement when they participated

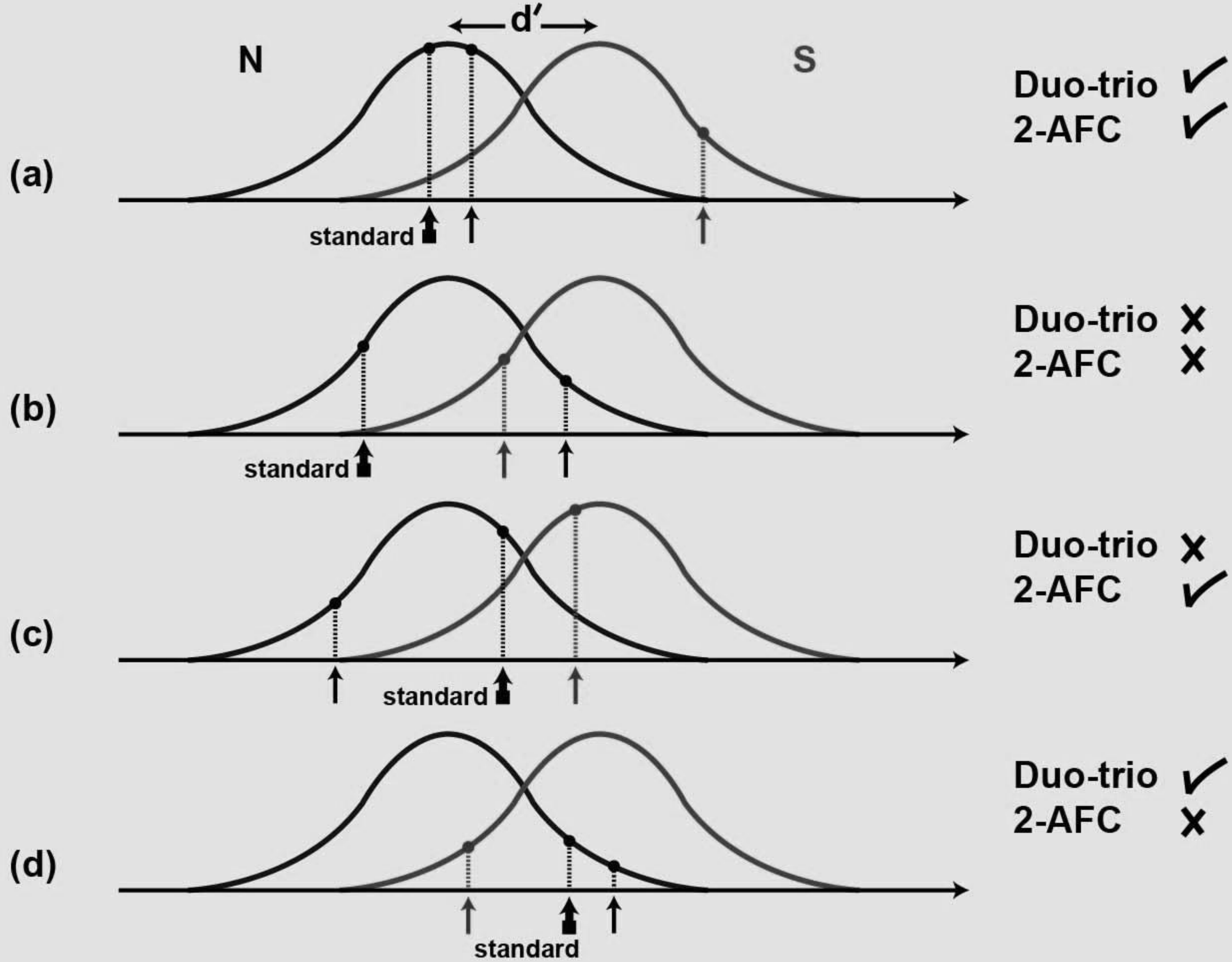
  - Triangle vs 3-AFC

  - Duo-trio vs 2-AFC

Triangle vs 3-AFC



DUO-TRIO vs 2-AFC (PAIRED COMPARISON)



PROPORTION CORRECT

d′	TRIANGLE	3-AFC
0.00	33.3%	33.3%
0.43	35%	46%
0.88	40%	60%
1.0	42%	64%
1.52	51%	77%
2.03	61%	87%
2.5	70%	93%

	d′	
PROPORTION CORRECT	TRIANGLE	3-AFC
33.3%	0.00	0.00
40%	0.88	0.23
50%	1.47	0.56
60%	1.98	0.89
70%	2.50	1.24
80%	3.13	1.65
90%	4.03	2.23

The triangle test is not as efficient as the 3AFC.
The difference has to be bigger (bigger d′) to get the same proportion of tests correct.

Different cognitive strategies

- Comparison of distance of difference

  - compare distances along the flavor intensity axis; choose the most distant one

- Comparison of magnitudes or intensities (Skimming)

  - compare input intensities; choose (skim off) appropriate one

Thus, different methods have different efficiency

Other effects

- Memory
- Sequence
- Cross-over
- .....

Counterbalance the experiments!