NATIONAL ACADEMIES OF SCIENCES, ENGINEERING, AND MEDICINE (NASEM)
METHODS WORKSHOP ON ASSESSING FOOD AND DIETARY SUPPLEMENT INTAKES

Best practices for measuring dietary intake: CHILDREN AGE 6-11 YEARS

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Practicing
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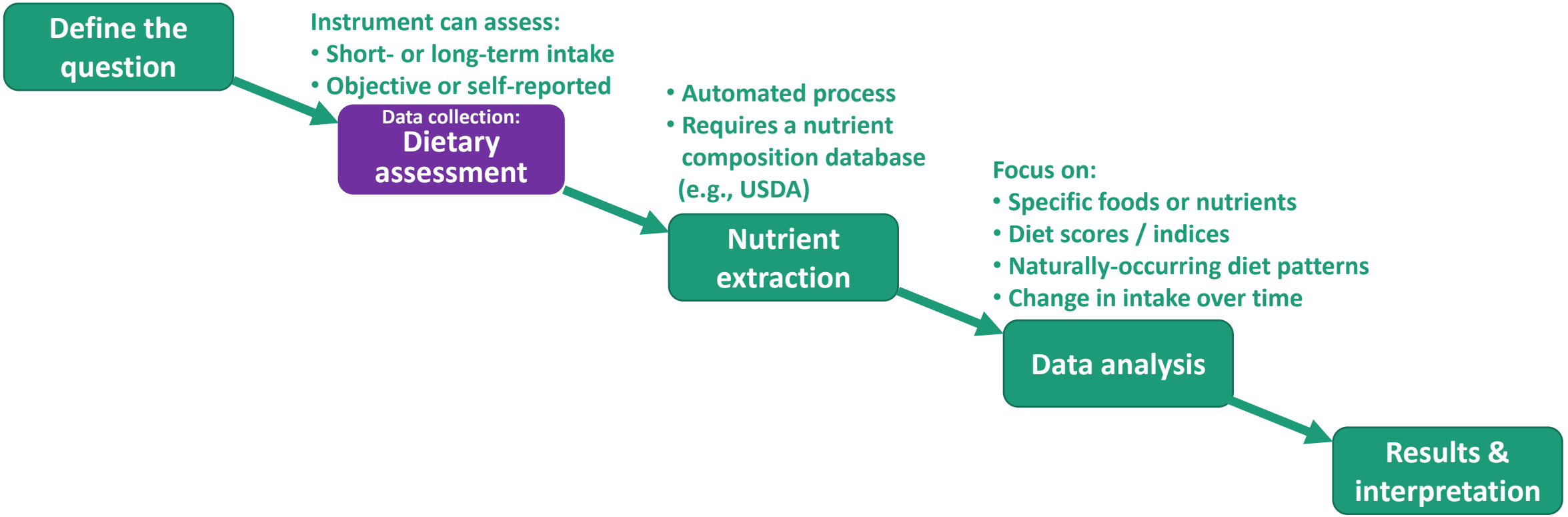
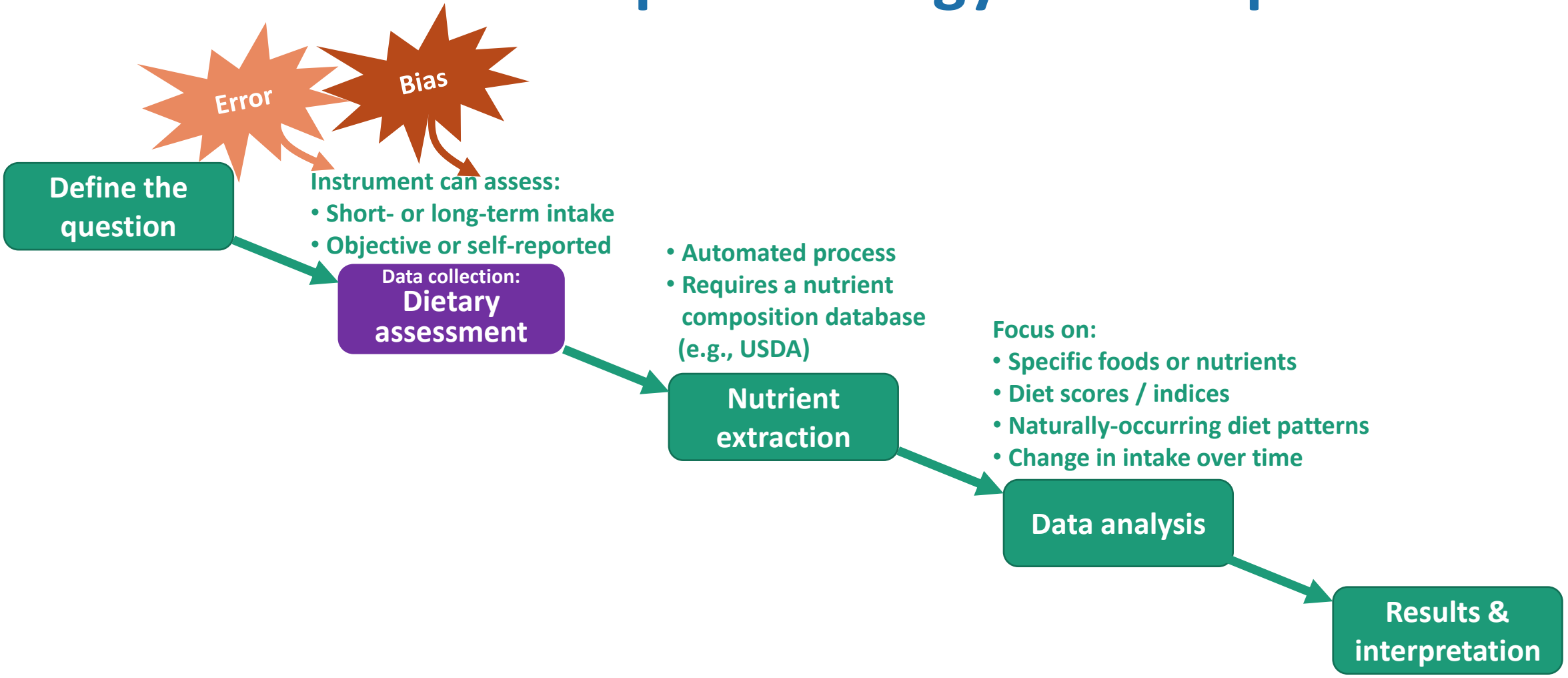
Nutritional epidemiology roadmap



Nutritional epidemiology roadmap



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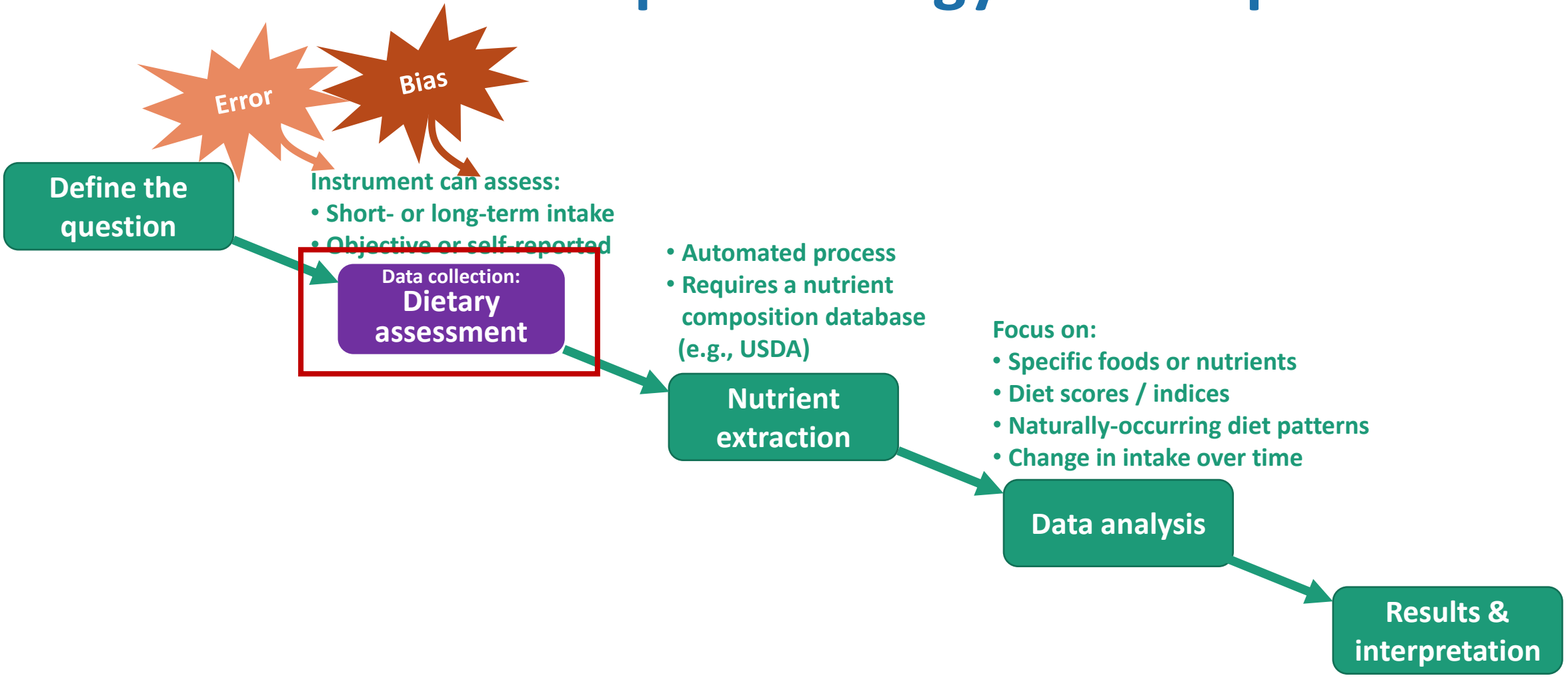

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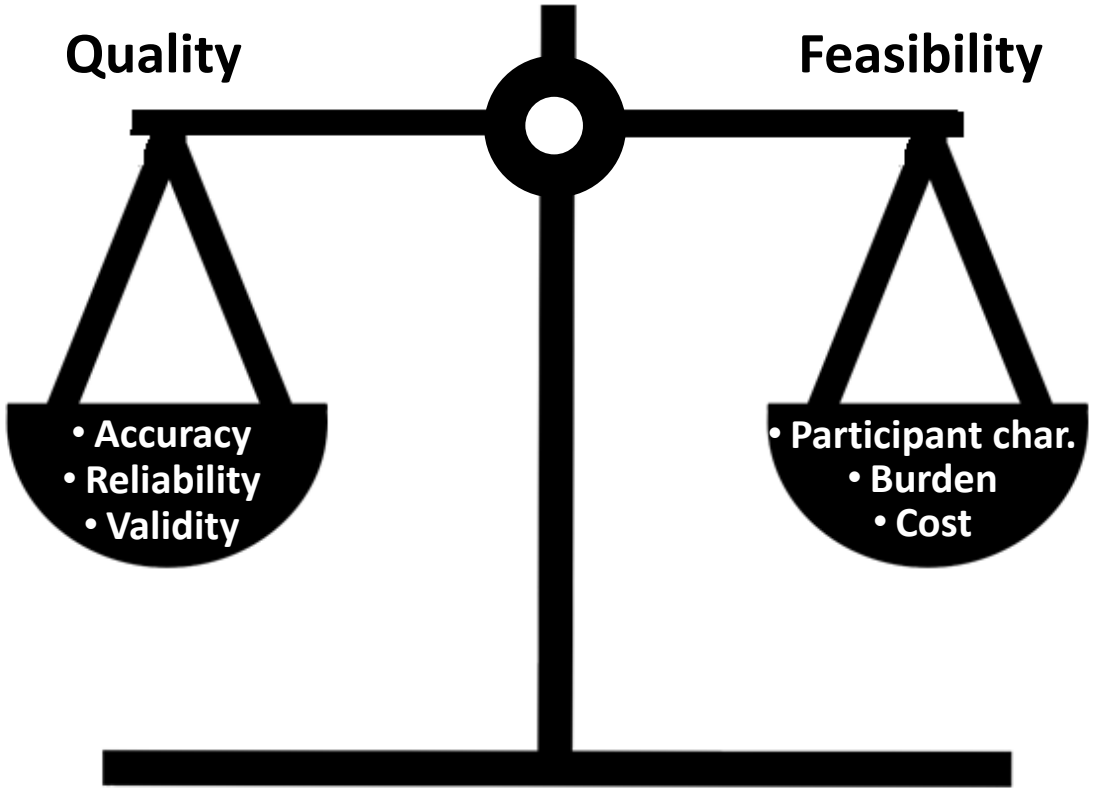

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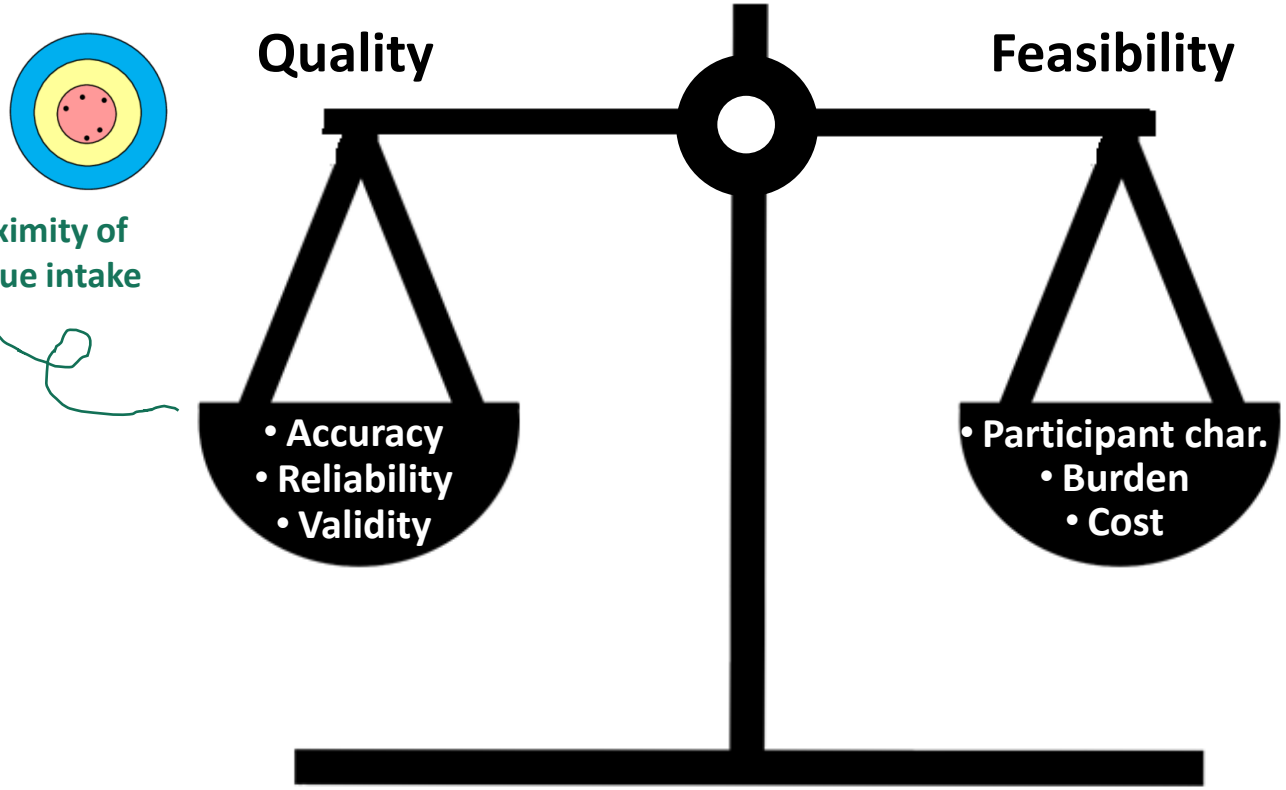
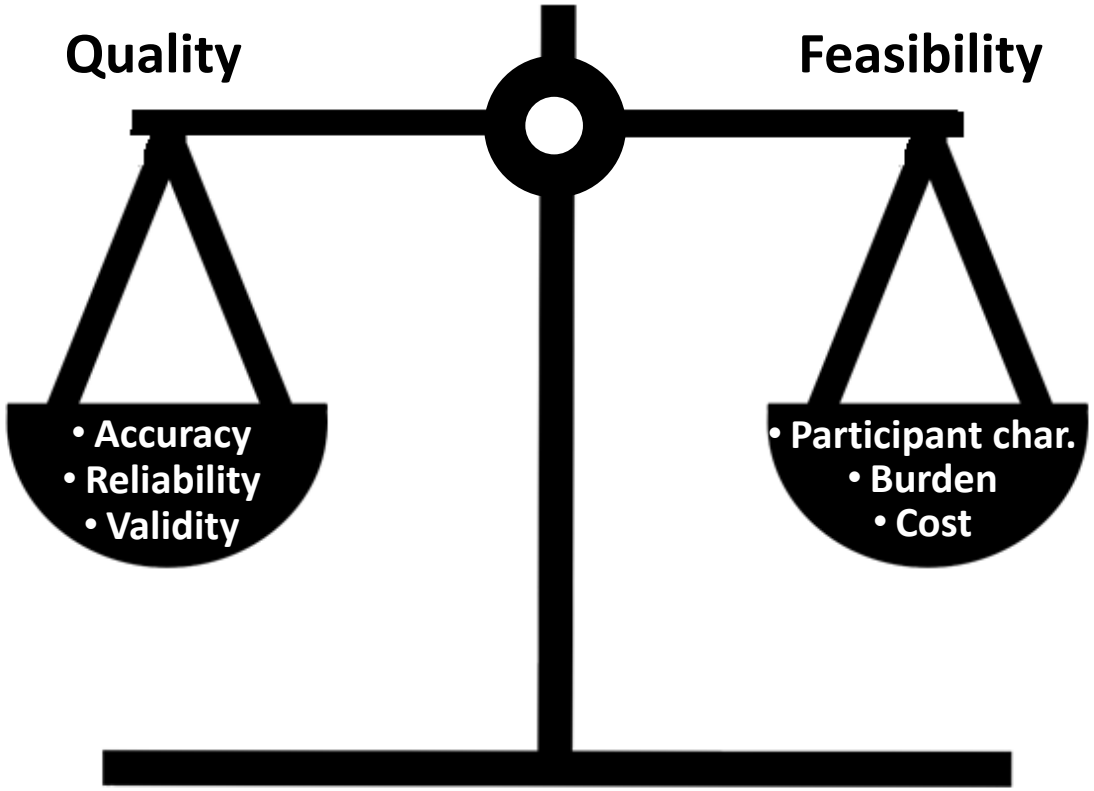


What is the best instrument for dietary assessment?

Accuracy: the proximity of measurement to true intake



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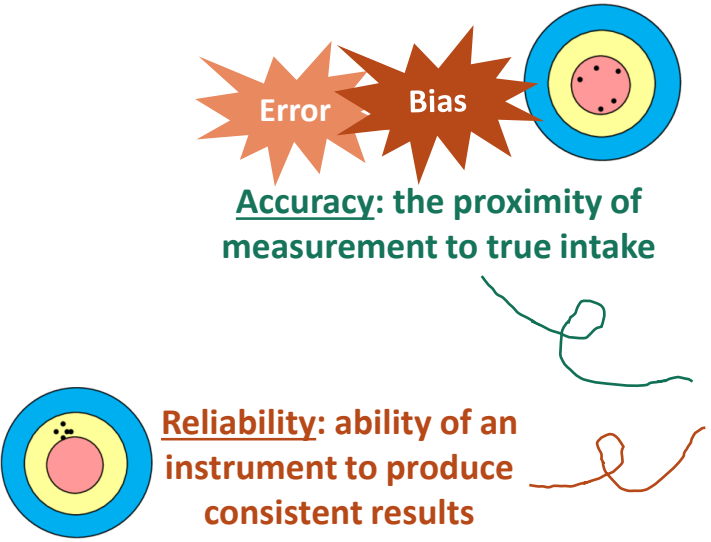
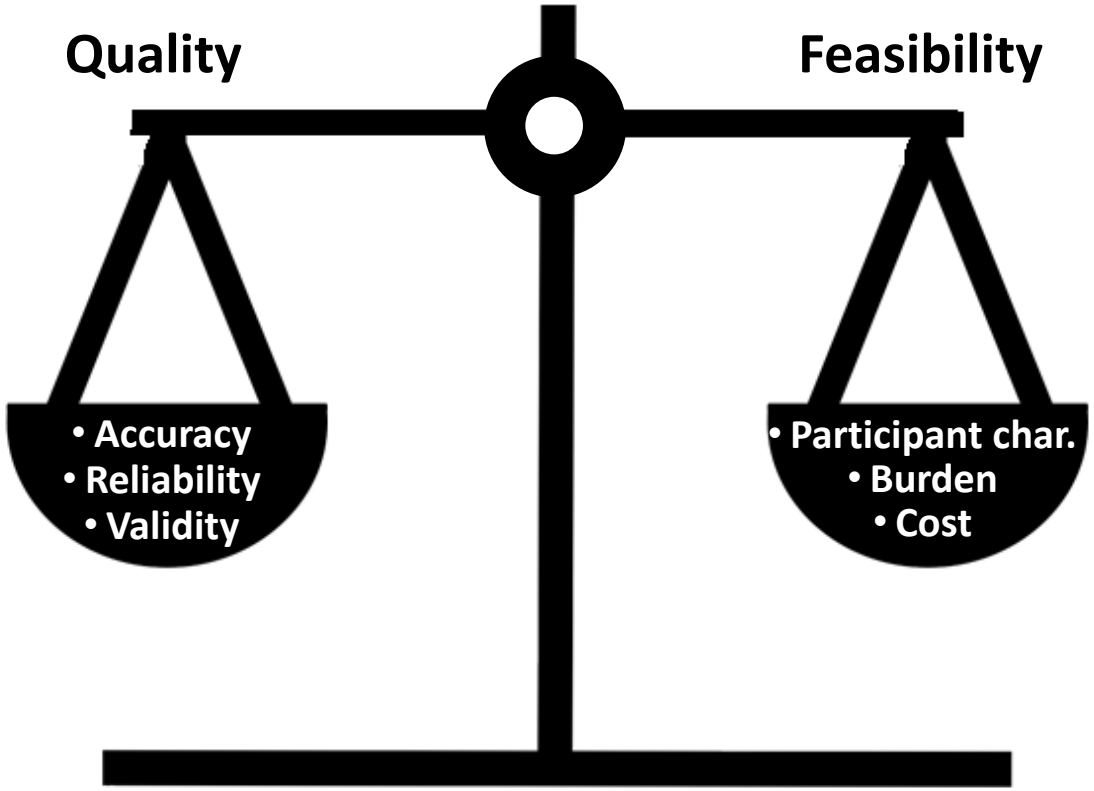


Accuracy: the proximity of measurement to true intake

Reliability: ability of an instrument to produce consistent results



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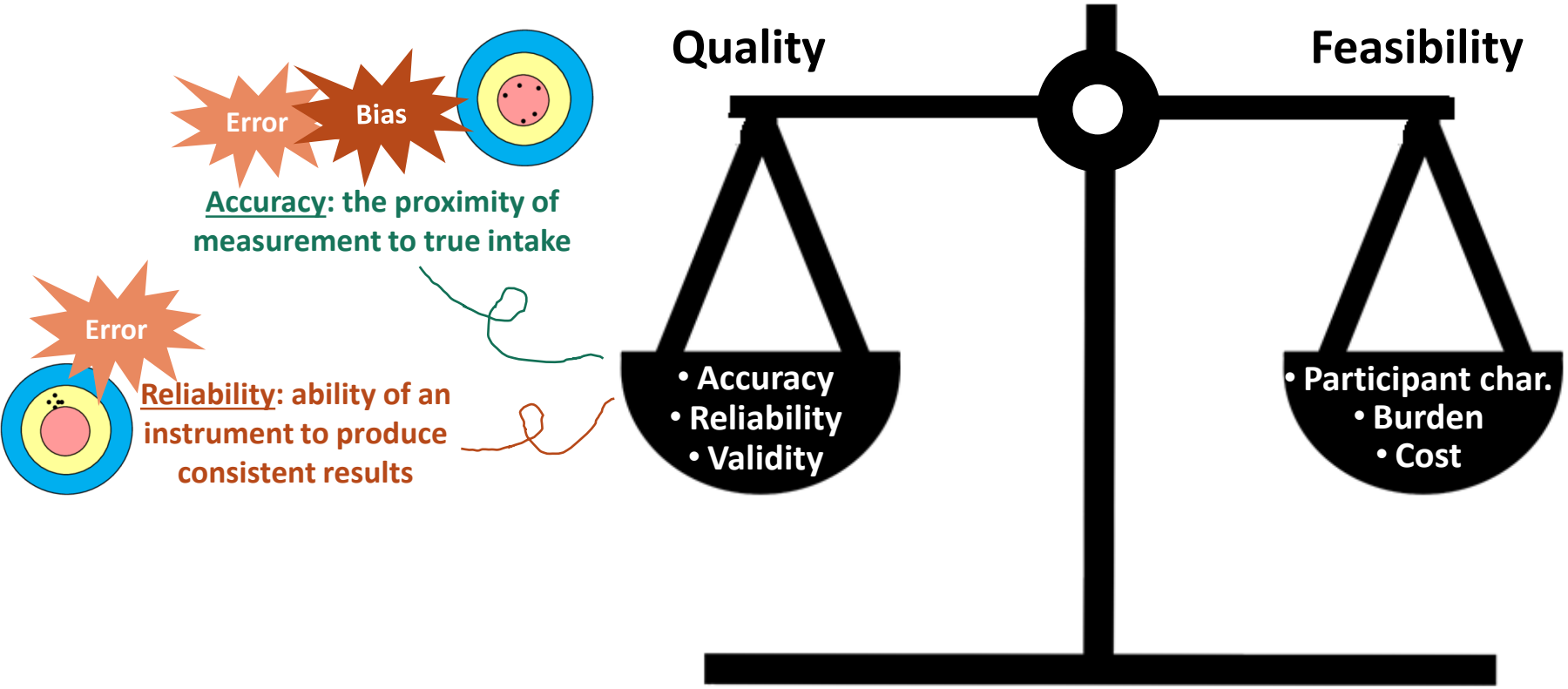

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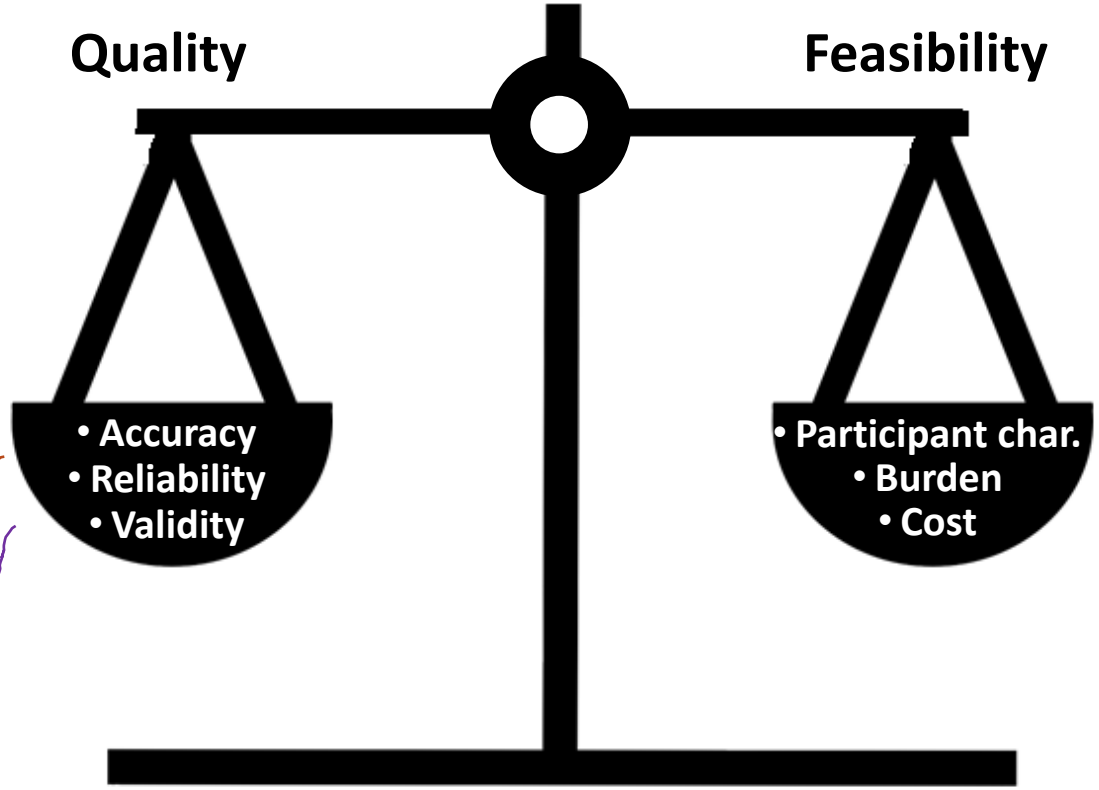
Accuracy: the proximity of measurement to true intake

Reliability: ability of an instrument to produce consistent results

Validity: extent to which an instrument captures the construct it is intended to reflect – both in the study sample and other populations



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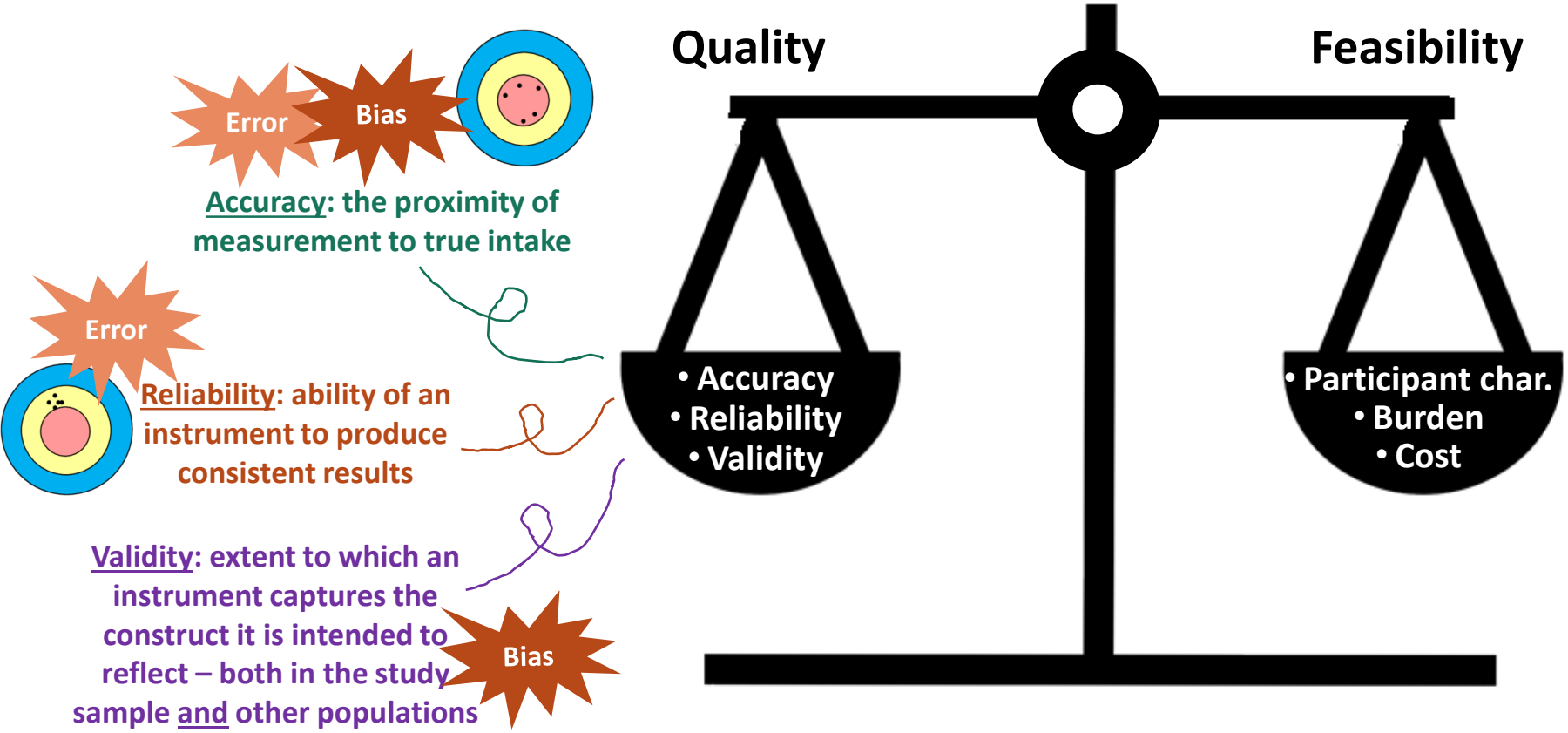

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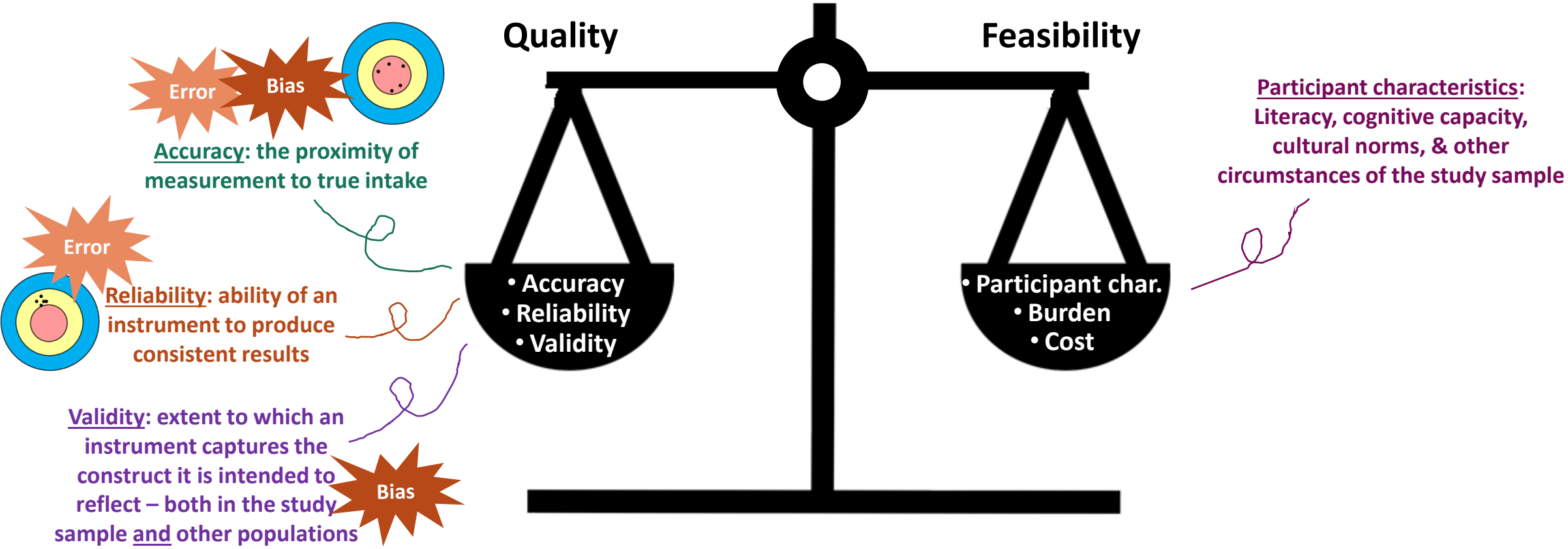

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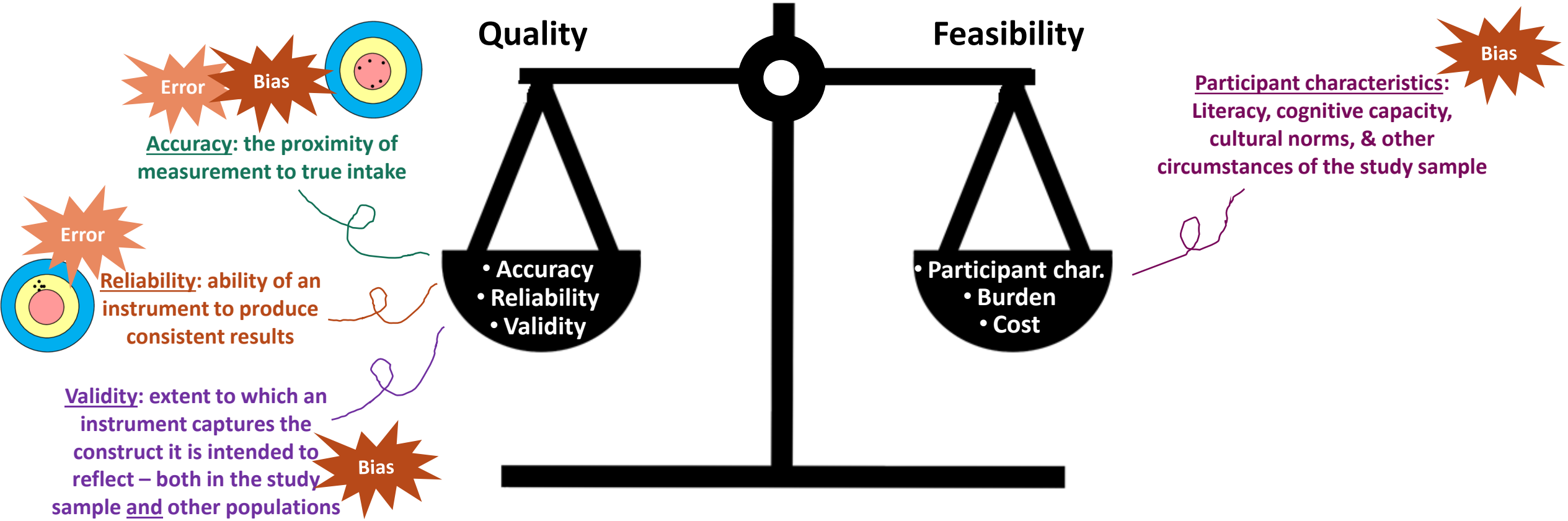

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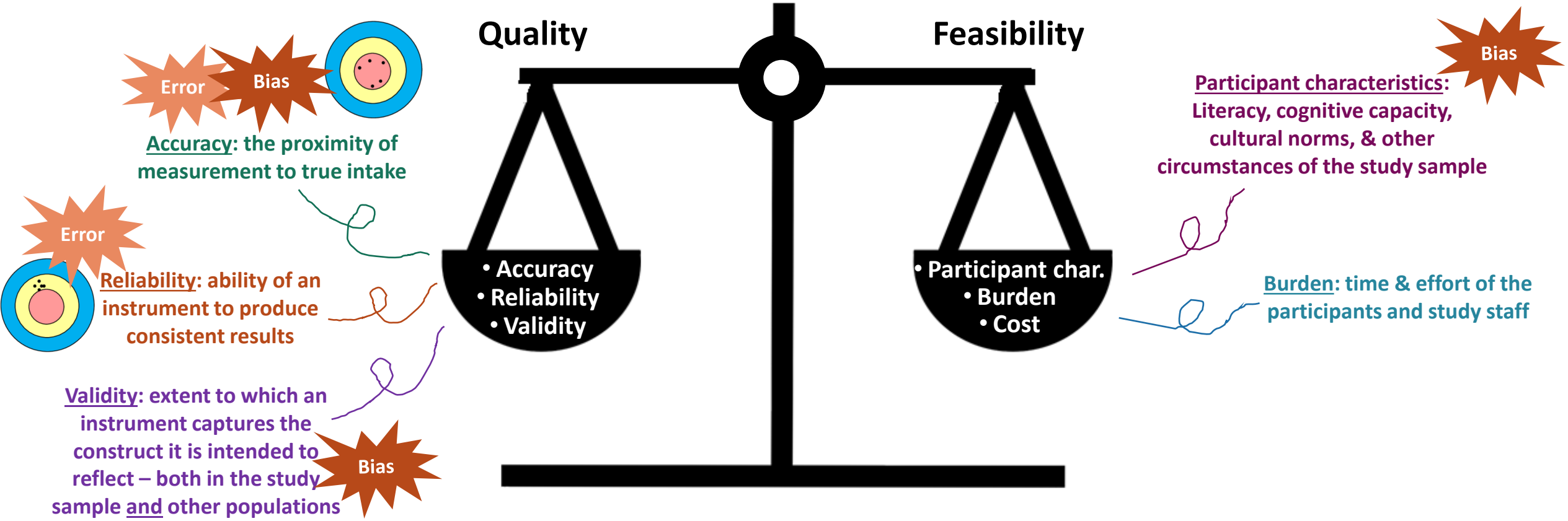

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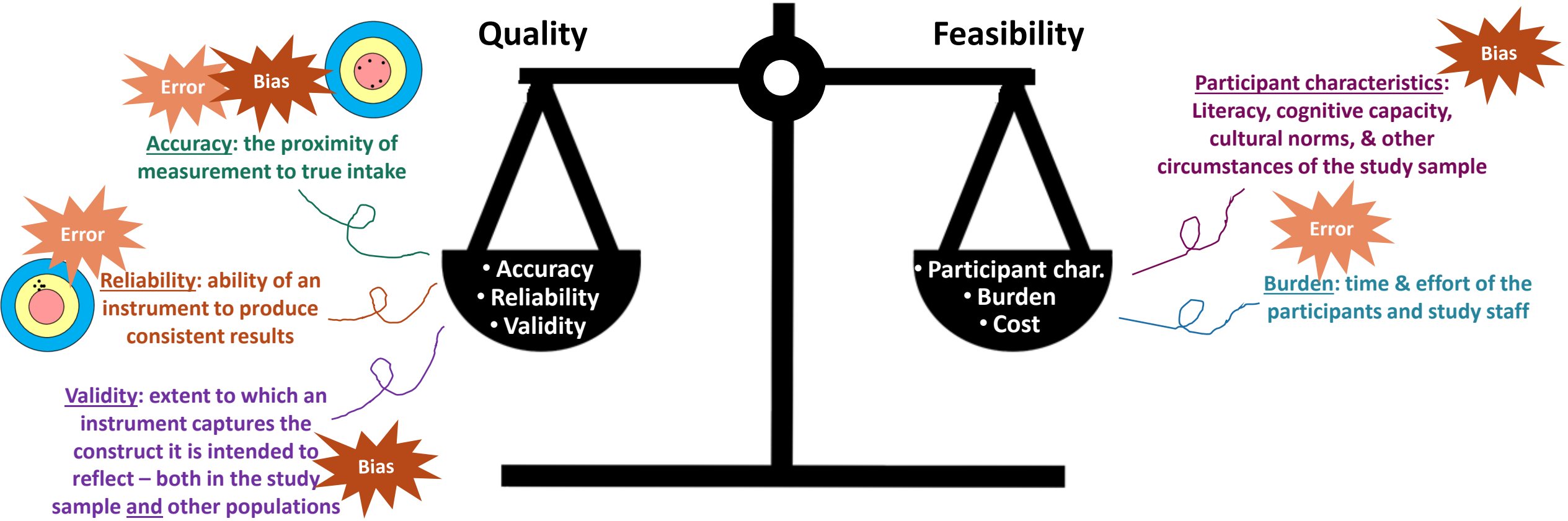

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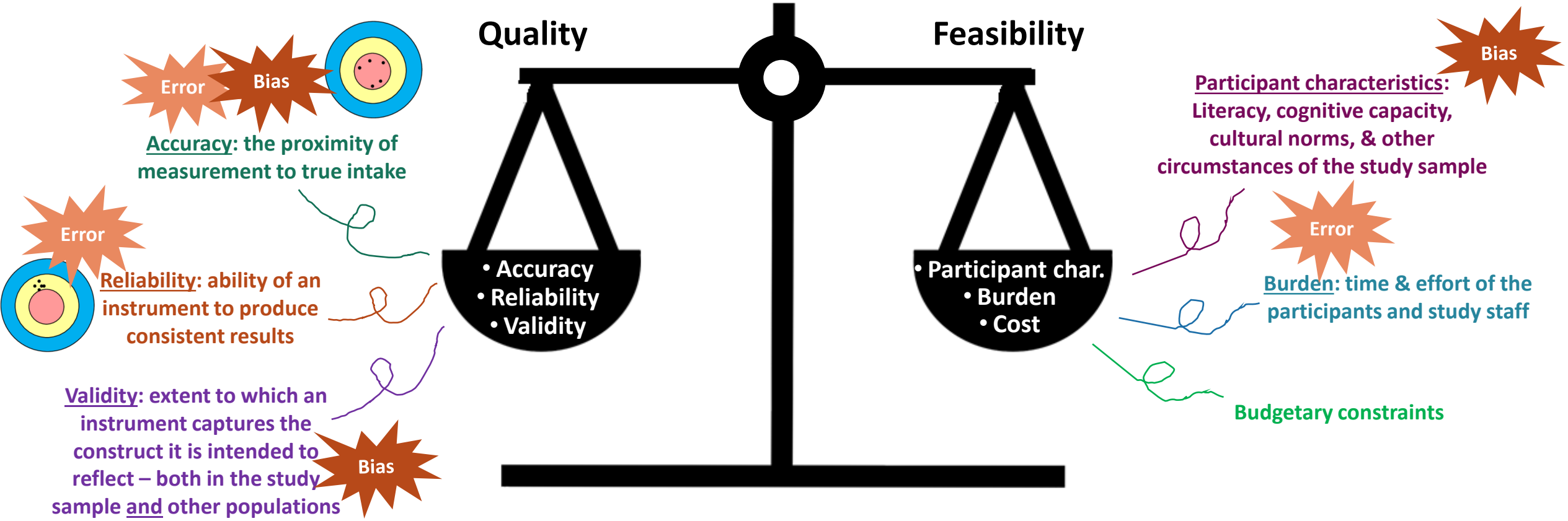

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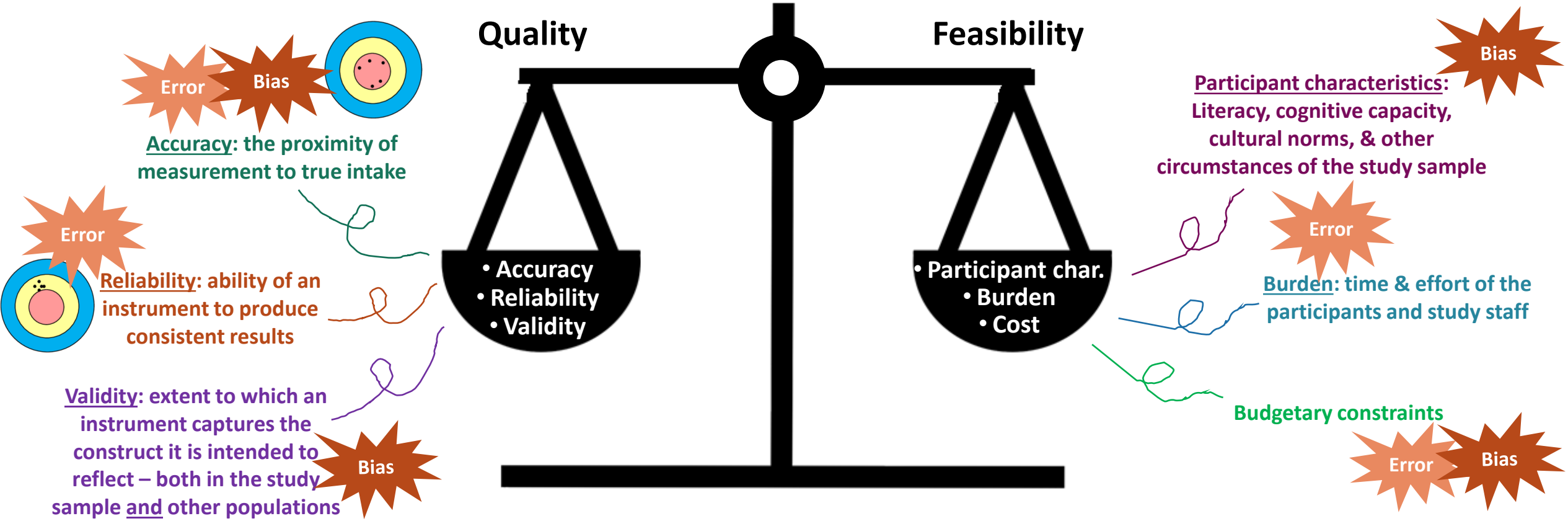

Instruments for dietary assessment in children 6-11 y

	FFQ	24-h recall	Weighed diet record	Meal observations	Biomarkers	Anthropometry
Methods						
Data collected						
Strengths						
Limitations						

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Methods	• Self- or interviewer-administered questionnaire • Generic memory					
Data collected	• Usual intake from past 3 mo. to past 1 year • Freq. of consumption • Portion sizes (some)					
Strengths	• Relevance to chronic disease • Cost-effective; suitable for large studies • Ideal data for deriving dietary patterns					
Limitations	• Specific to cultural habits of sample • Difficult to quantify absolute intake • Recall bias					

- **Long-term intake**
- **Reliable & valid for specific populations**
- **Low accuracy**

Low burden

Instruments for dietary assessment in children 6-11 y

	FFQ	24-h recall	Weighed diet record	Meal observations	Biomarkers	Anthropometry
Methods	• Self- or interviewer-administered questionnaire • Generic memory	• Open-ended, interviewer-prompted recall • Episodic memory				
Data collected	• Usual intake from past 3 mo. to past 1 year • Freq. of consumption • Portion sizes (some)	• Intake over the past 24 hours				
Strengths	• Relevance to chronic disease • Cost-effective; suitable for large studies • Ideal data for deriving dietary patterns	• Detailed intake data • Low respondent burden • No literacy required				
Limitations	• Specific to cultural habits of sample • Difficult to quantify absolute intake • Recall bias	• Requires multiple passes • May not capture episodically-consumed foods (e.g., fish) • Interviewer training • Recall & interviewer bias				

- **Long-term intake**
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Low burden

- **Short-term intake**
- **Reliable, fairly accurate, & valid**

Medium burden

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	FFQ	24-h recall	Weighed diet record	Meal observations	Biomarkers	Anthropometry
Methods	• Self- or interviewer-administered questionnaire • Generic memory	• Open-ended, interviewer-prompted recall • Episodic memory	• Open-ended self-recorded diet diary • Use of scale to weigh portions			
Data collected	• Usual intake from past 3 mo. to past 1 year • Freq. of consumption • Portion sizes (some)	• Intake over the past 24 hours	• Actual intake recorded during a short-term period (2 days to 2 weeks)			
Strengths	• Relevance to chronic disease • Cost-effective; suitable for large studies • Ideal data for deriving dietary patterns	• Detailed intake data • Low respondent burden • No literacy required	• Detailed & exact intake data • No interviewer • No recall bias			
Limitations	• Specific to cultural habits of sample • Difficult to quantify absolute intake • Recall bias	• Requires multiple passes • May not capture episodically-consumed foods (e.g., fish) • Interviewer training • Recall & interviewer bias	• Large respondent & staff burden • Multiple days to assess usual intake • $$$ • Recording diet may cause dietary changes			
	• **Long-term intake** • **Reliable & valid for specific populations** • **Low accuracy**	• **Short-term intake** • **Reliable, fairly accurate, & valid**	• **Short-term intake** • **Accurate, reliable, & valid**			
	Low burden	**Medium burden**	**High burden**			

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Data collected	• Usual intake from past 3 mo. to past 1 year • Freq. of consumption • Portion sizes (some)	• Intake over the past 24 hours	• Actual intake recorded during a short-term period (2 days to 2 weeks)	• Precise information about amounts and types of foods consumed		
Strengths	• Relevance to chronic disease • Cost-effective; suitable for large studies • Ideal data for deriving dietary patterns	• Detailed intake data • Low respondent burden • No literacy required	• Detailed & exact intake data • No interviewer • No recall bias	• Free of recall bias • Low participant burden		
Limitations	• Specific to cultural habits of sample • Difficult to quantify absolute intake • Recall bias	• Requires multiple passes • May not capture episodically-consumed foods (e.g., fish) • Interviewer training • Recall & interviewer bias	• Large respondent & staff burden • Multiple days to assess usual intake • $$$ • Recording diet may cause dietary changes	• Staff burden • Awkward for participant • Dietary changes due to observation • Not ideal for meals eaten outside of home		
	• **Long-term intake** • **Reliable & valid for specific populations** • **Low accuracy**	• **Short-term intake** • **Reliable, fairly accurate, & valid**	• **Short-term intake** • **Accurate, reliable, & valid**	• **Short-term intake** • **Accurate & reliable** • **Validity may depend**		
	Low burden	**Medium burden**	**High burden**	**High (staff) burden**		

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	FFQ	24-h recall	Weighed diet record	Meal observations	Biomarkers	Anthropometry
Methods	• Self- or interviewer-administered questionnaire • Generic memory	• Open-ended, interviewer-prompted recall • Episodic memory	• Open-ended self-recorded diet diary • Use of scale to weigh portions	• Trained rater observes subject at mealtime	• Biochemical measurement from tissue	• Anthropometry • Direct measurement of fat mass (DXA, ADP, BIA)
Data collected	• Usual intake from past 3 mo. to past 1 year • Freq. of consumption • Portion sizes (some)	• Intake over the past 24 hours	• Actual intake recorded during a short-term period (2 days to 2 weeks)	• Precise information about amounts and types of foods consumed	• Biomarker concentration	• Weight, height, circumferences, skinfolds • Fat mass, fat-free mass
Strengths	• Relevance to chronic disease • Cost-effective; suitable for large studies • Ideal data for deriving dietary patterns	• Detailed intake data • Low respondent burden • No literacy required	• Detailed & exact intake data • No interviewer • No recall bias	• Free of recall bias • Low participant burden	• Objective assessment of biomarker intake and metabolism • No literacy required • No recall bias	• Objective but crude assessment of TEI and macronutrient intake • Anthro is cost & time-efficient
Limitations	• Specific to cultural habits of sample • Difficult to quantify absolute intake • Recall bias	• Requires multiple passes • May not capture episodically-consumed foods (e.g., fish) • Interviewer training • Recall & interviewer bias	• Large respondent & staff burden • Multiple days to assess usual intake • $$$ • Recording diet may cause dietary changes	• Staff burden • Awkward for participant • Dietary changes due to observation • Not ideal for meals eaten outside of home	• An assessment of dietary intake and metabolism • Not all nutrients have biomarkers (e.g., Ca) • $$ for collecting, storing, and shipping samples, & assaying biomarkers	• Does not allow specific assessment of diet intake • DXA and ADP are $$
	• **Long-term intake** • **Reliable & valid for specific populations** • **Low accuracy**	• **Short-term intake** • **Reliable, fairly accurate, & valid**	• **Short-term intake** • **Accurate, reliable, & valid**	• **Short-term intake** • **Accurate & reliable** • **Validity may depend**	• **Short or long-term intake** • **Reliable & valid for some nutrients**	• **Long-term energy intake** • **Crude but reliable & valid for energy intake**
	Low burden	**Medium burden**	**High burden**	**High (staff) burden**	**Low/med burden**	**Low/med burden**

Best practices for assessing diet in children 6-11 y

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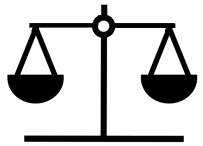
Best balance between quality & feasibility: 24-h recall

- Interviewer-administered 24-h recall covering 2 weekdays and 1 weekend day
  - Caregiver proxy, especially for children ≤10 y
- Interviewer should provide a relaxed and comfortable environment to promote optimal recall
- Supplement recall with food records or cafeteria food lists to inform the interviewer

(Trolle et al. *Eur J Clin Nutr* 2011 65; S84-S86)



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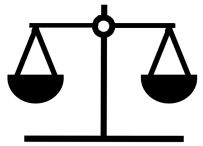

Highest feasibility, especially for large studies: FFQ

- Caregiver proxy
- FFQ should be tailored to the age and cultural norms of the study population
  - Options for U.S. youth, validated for older children:
    - ✓ Block Kid's FFQ (validated for 10-17 y)
    - ✓ Youth Adolescent FFQ (validated for 9-18 y)
  - In mixed race samples, this instrument may have reduced validity

Best practices for assessing diet in children 6-11 y

Analytical recommendations

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Analytical recommendations

- Total energy intake (TEI) adjustment to improve accuracy, reliability, and validity of estimates (i.e., mitigate error and some amount of bias)
  - ➢ Also controls for confounding and simulates a dietary intervention (strengthens causal inference)

Best

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  - ➢ A
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Table 11–2. Correlations (Spearman *r*) between intakes of specific nutrients[a]

	Protein	Total fat	Saturated fat	Polyunsaturated fat	Total carbohydrate	Crude fiber	Vitamin A	Sucrose	Vitamin B_6	Vitamin C	Cholesterol	Alcohol
Protein	—	—	—	—	—	—	—	—	—	—	—	—
Total fat	0.44 −0.13 −0.14	—	—	—	—	—	—	—	—	—	—	—
Saturated fat	0.42 −0.10 −0.10	0.93 0.74 0.74	—	—	—	—	—	—	—	—	—	—
Polyunsaturated fat	0.28 −0.08 −0.11	0.73 0.56 0.56	0.52 0.02 0.02	—	—	—	—	—	—	—	—	—
Total carbohydrate	0.39 −0.34 −0.23	0.56 −0.48 −0.52	0.47 −0.43 −0.57	0.41 −0.15 −0.14	—	—	—	—	—	—	—	—
Crude fiber	0.36 0.32 0.24	0.01 −0.44 −0.45	−0.06 −0.51 −0.51	0.12 −0.07 −0.08	0.45 0.35 0.45	—	—	—	—	—	—	—
Vitamin A	0.45 0.40 0.37	0.08 −0.33 −0.32	0.03 −0.38 −0.36	0.10 −0.08 −0.08	0.66 0.13 0.19	0.66 0.64 0.61	—	—	—	—	—	—
Sucrose	0.21 −0.54 −0.45	0.53 −0.18 −0.21	0.46 −0.19 −0.25	0.37 −0.13 −0.11	0.18 0.60 0.56	0.18 −0.17 −0.05	0.14 −0.20 −0.12	—	—	—	—	—
Vitamin B_6	0.56 0.44 0.41	0.15 −0.49 −0.48	0.14 −0.39 −0.38	0.12 −0.22 −0.22	0.65 0.26 0.33	0.65 0.61 0.59	0.57 0.53 0.59	0.22 −0.23 −0.16	—	—	—	—
Vitamin C	0.34 0.32 0.26	0.002 −0.47 −0.45	−0.05 −0.46 −0.44	−0.00 −0.14 −0.15	0.61 0.17 0.34	0.61 0.62 0.59	0.13 0.60 0.58	0.13 −0.12 −0.04	0.55 0.53 0.51	—	—	—
Cholesterol	0.60 0.58 0.50	0.51 0.16 0.19	0.55 0.22 0.26	0.26 −0.02 −0.04	0.05 −0.36 −0.32	0.05 −0.00 −0.07	0.25 −0.17 0.13	0.18 −0.34 −0.30	0.24 0.09 0.05	0.12 0.11 0.03	—	—
Alcohol	−0.03 −0.16 −0.13	0.04 −0.12 −0.12	0.12 0.06 0.05	−0.01 −0.13 −0.13	−0.15 −0.50 −0.54	−0.14 −0.19 −0.18	−0.03 −0.10 −0.07	−0.06 −0.14 −0.21	−0.06 −0.16 −0.14	−0.06 −0.14 −0.12	−0.04 −0.15 −0.12	—
Energy	0.59	0.86	0.81	0.59	0.82	0.24	0.25	0.71	0.40	0.19	0.47	0.15

Willet W & Stampfer M. Ch 11: Implications of Total Energy Intake for Epidemiologic Analyses. In: *Nutritional Epidemiology*, 2nd Ed. Oxford University Press 1998, New York, NY.

Best practices for assessing diet in children 6-11 y

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  - ➢ Also controls for confounding and simulates a dietary intervention (strengthens causal inference)

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Performance of 24-h recall in children 10-13 y [Raffoul et al. J Nutr 2019; 149:1019-1026]

TABLE 4 Mean amounts of true and reported energy and nutrient intake for the lunch meal among school-age children ($n = 100$)[1]

Overestimation of nutrients: calories, protein, and sodium

Nutrient	Mean amount		
	True (SE)	Reported (SE)	Difference between true and reported (SE)[2]
Calories, kcal	542 (10)	755 (46)	−212 (44.8)*
Protein, g	20.3 (0.5)	27.1 (1.8)	−6.8 (1.7)*
Potassium, mg	762 (23)	798 (56)	−36.1 (56.0)
Sodium, mg	696 (12)	1239 (73)	−543 (73.9)*

TABLE 5 Mean amounts truly consumed and reported by food and beverage among school-age children ($n = 82$)[1]

Underestimation of cookies, juice, and possibly milk

Food or beverage[2]	Number of children who truly consumed the item	Mean amount, g		
		True (SE)	Reported (SE)	Difference between true and reported (SE)[3]
Pizza	100	99.0 (1.7)	104 (10.7)	−5.0 (10.5)
Dip	90	9.8 (1.2)	7.7 (2.0)	2.0 (2.2)
Cookie	98	37.2 (1.2)	17.3 (2.5)	19.7 (2.6)*
Yogurt	84	41.9 (4.2)	51.8 (8.8)	−9.9 (8.5)
Water	20	236 (38.5)	280 (50.3)	−43.9 (85.3)
Milk	35	250 (0.8)	183 (53.6)	67.3 (53.8)
Juice	40	182 (7.4)	56.7 (14.7)	126 (14.7)*

Best practices for assessing diet in children 6-11 y

Analytical recommendations

- Total energy intake (TEI) adjustment to improve accuracy, reliability, and validity of estimates (i.e., mitigate error and some amount of bias)
  - Also controls for confounding and simulates a dietary intervention (strengthens causal inference)
- For recall-based instruments, children underestimate intake of yummy foods and overestimate macronutrient and total energy intake (Raffoul et al. J Nutr 2019; 1019-1026)
  - Removing error to improve accuracy:
    - Regression-based corrections for non-differential error
  - Correcting bias to improve reliability & validity:
    - Predictive algorithms to identify new thresholds of excessive/adequate/inadequate intake
- Be aware of how error or bias may be affecting your findings depending on the instrument used for dietary assessment, and interpret results accordingly

Best practices for assessing diet in children 6-11 y

Analytical recommendations

- Total energy intake (TEI) adjustment to improve accuracy, reliability, and validity of estimates (i.e., mitigate error and some amount of bias)
  - Also controls for confounding and simulates a dietary intervention (strengthens causal inference)
- For recall-based instruments, children underestimate intake of yummy foods and overestimate macronutrient and total energy intake (Raffoul et al. J Nutr 2019; 1019-1026)
  - Removing error to improve accuracy:
    - Regression-based corrections for non-differential error
  - Correcting bias to improve reliability & validity:
    - Predictive algorithms to identify new thresholds of excessive/adequate/inadequate intake
- Be aware of how error or bias may be affecting your findings depending on the instrument used for dietary assessment, and interpret results accordingly

Thank you!

Sefton – a precocious 4 y-old; not quite 6-11 y