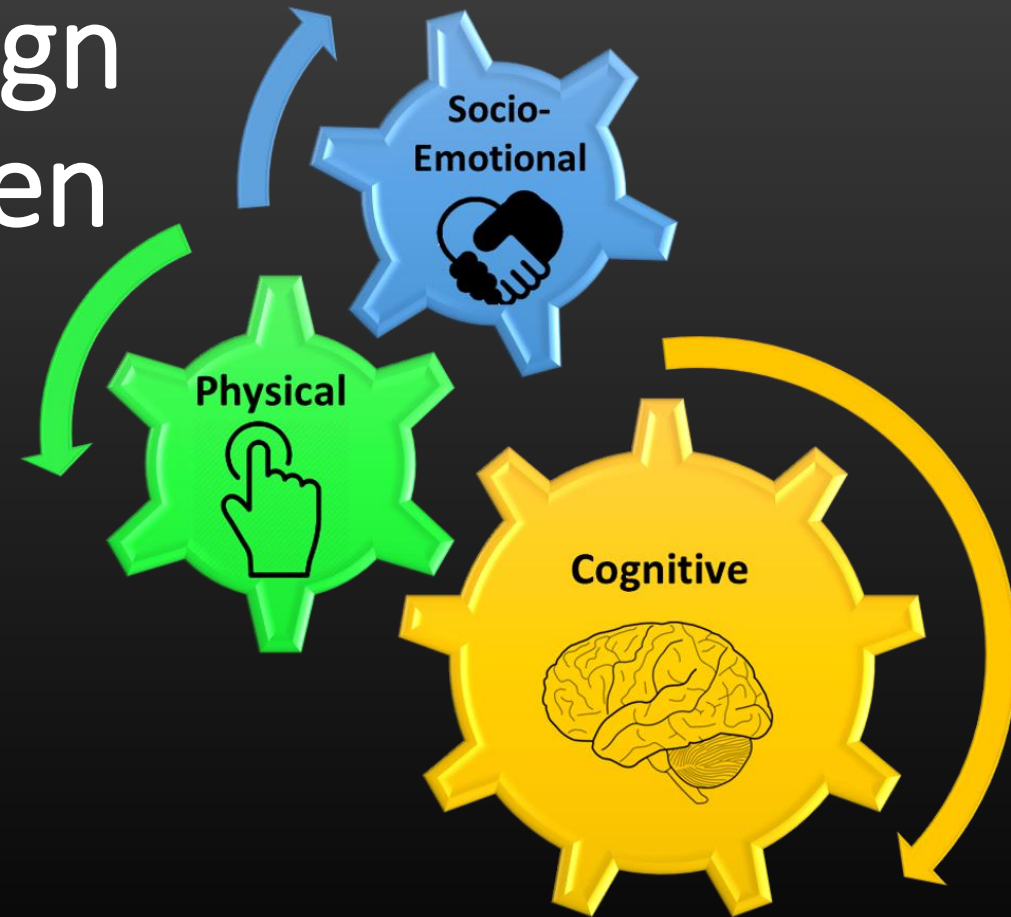


A Framework of Touchscreen Interaction Design Recommendations for Children (TIDRC)

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Research-Practice Gaps in HCI

- Beck & Ekbja, CHI 2018 [8], noted:
 - “...theory — the academic side of HCI research — lacks utility and applicability for practice. And **this ...problem... goes back decades to the early days of the field...1985...**”
- Buie et al ran SIGs at CHI 2010 [14] and 2013 [15] and continued calls for “**practitioner-friendly dissemination** of [HCI] **results**”.



Research Questions

- **RQ1:** How can we synthesize evidence-based design recommendations for children's touchscreen interfaces?
 - Literature review and meta-analysis
- **RQ2:** Is there a gap between research and practice for touchscreen interface design for children, and if so, how can we characterize it?
 - Empirical analysis of existing apps
- **RQ3:** If this gap exists, how can we work towards closing it?
 - Identification of gaps and future work



Literature Review

- 31 total papers
- Inclusion criteria:
peer-reviewed research paper
reporting an **empirical user study** of children (under age 12) that led to **design recommendations**



Interaction Design and Children

Juan Pablo Hourcade

Characterizing How Interface Complexity Affects Children's Touchscreen Interactions

Julia Woodward¹, Alex Shaw¹, Annie Luc¹, Brittany Craig^{2†}, Juthika Das¹, Phillip Hall Jr.¹, Akshay Holla^{3‡}, Germaine Irwin⁴, Danielle Sikich^{5¶}, Quincy Brown⁶, Lisa Anthony¹

¹Dept of CISE, ²St. Catherine University, ³User Testing, Inc., ⁴Mountain Marymount, ⁵University of Maryland, ⁶Western Oregon University, [†]University of Maryland, [‡]University of Maryland, [¶]University of Maryland

Touchscreen Prompts for Preschoolers: Designing Developmentally Appropriate Techniques for Teaching Young Children to Perform Gestures

Alexis Hiniker, Kiley Sobel, Sungsoo (Ray) Hong, Hyewon Suh, India Irish, Daniella Kim, Julie A. Kientz

Computers & Education 68 (2013) 505–521



Contents lists available at SciVerse ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu



Young students using iPads: App design and content influences on their learning pathways

Garry Falloon*



Selection of Touch Gestures for Children's Applications

Nor Azah Abdul Aziz
Creative Multimedia Department
Faculty of Art, Computing and Creative Industry

Firat Batmaz, Roger Stone and Paul Wai Hing Chung
Computer Science Department
Loughborough University

Int. J. Human-Computer Studies 74 (2015) 54–76



Contents lists available at ScienceDirect

Int. J. Human-Computer Studies

journal homepage: www.elsevier.com/locate/ijhcs



Touch interaction for children aged 3 to 6 years: Experimental findings and relationship to motor skills[☆]

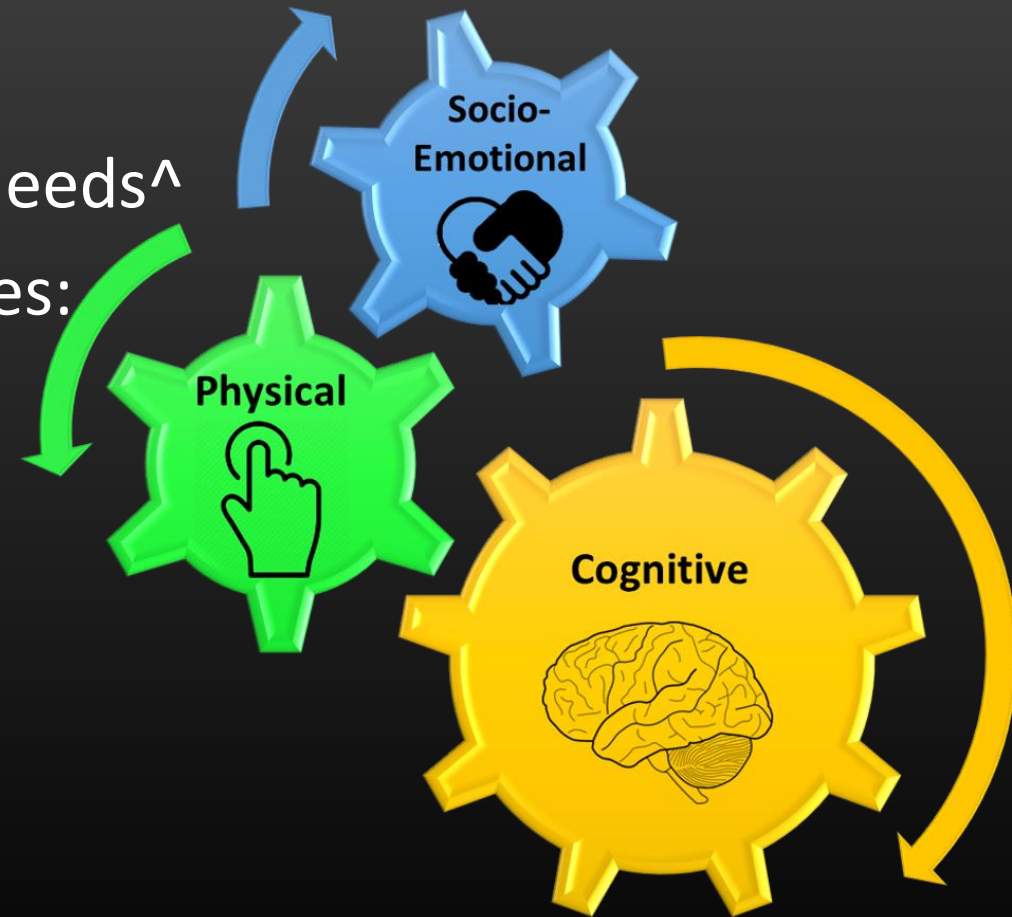
Radu-Daniel Vatavu*, Gabriel Cramariuc, Doina Maria Schipor

University Stefan cel Mare of Suceava, str. Universitatii nr. 13, 720229 Suceava, Romania



TIDRC Framework

- 31 papers → 57 design recommendations
- **Cognitive**, **physical**, and **socio-emotional** needs[^]
- Mapped to Piagetian* developmental stages:
 - Pre-operational in ages **2 to 7** (86% of recs)
 - Concrete operational in ages **7 to 11** (31%)
 - Or both stages from ages **2 to 11** (26%)



TIDRC Framework Example

Empirical Evidence:

“children [ages 2 to 4] found it difficult and got confused when using gestures on a crowded interface design” [Aziz et al, SAI 2013*, p. 725].



Actionable Design

Recommendation:

“avoid using visually complex application backgrounds as children can get confused when interacting on them” (B5, TIDRC)



*Aziz et al, SAI 2013 [6]

TIDRC Framework

• Cognitive

- Visual design features
- Audio features
- Interactive features
- Application responsiveness
- Informational features

• Physical

- Gesture and target features

• Socio-Emotional

Contextual features



framework is a one-sheet download

Interface Dimensions		Evidence-Based Design Recommendations		Cognitive, Physical, and Socio-Emotional Needs of Children	
Visual Design Features	Graphics (G)	1.	Be consistent with images or graphics used in the real world [6]. (ages 2-7)	COGNITIVE	
	Application Background (B)	2.	Remove visual embellishments from symbols to support children's limited capability for symbol-referent mapping [26,35]. (ages 2-7)		
		3.	Use child-like on-screen characters as guides or pedagogical agents to improve learning outcomes [17,24]. (ages 2-11)		
	Text Font Size (F)	7.	Use a minimum of 14-point font size to help children read faster [11]. (ages 7-11)		
Audio Features	Types of Sound (S)	8.	*Avoid using Times font style as children report it to be significantly less easy to read [11]. (ages 7-11)		
		9.	*Make sure that every sound used in the interface has a specific meaning and function [26]. (ages 2-7)		
		10.	Avoid using background music with videos, especially for children ages 5 and under [16,58]. (ages 2-7)		
Interactive Features	Clickable Items (CI)	11.	Consider using narrative-style sound elements as they foster children's language development [43,65]. (ages 2+)		
		12.	Use audio features (e.g., sound effects, vocalization) to draw attention to important content for learning purposes [16,26]. (ages 2-7)		
		13.	Visually differentiate clickable elements from the rest of the screen, e.g., use different colors or dark outlines [26,58,66]. (ages 2-7)		
	Menu Complexity (M)	14.	*Avoid placing small interactive elements at the screen edges, especially in visually complex interface designs [71]. (ages 2-11)		
		15.	Be careful when using animated hotspots to capture children's attention as they may distract from learning [62,65]. (ages 2-11)		
		16.	Limit the behavior of interactive elements to their sole purpose, e.g., avoid extraneous animations or sounds [26,65]. (ages 2-11)		
	Interaction Prompts (I)	17.	Avoid using hierarchical menus as young children may have difficulty navigating these successfully [17,23,36]. (ages 2-11)		
		18.	*Provide a means to reverse children's actions in order to support their exploratory behavior [36]. (ages 2-7)		
		19.	Provide explicit scaffolding such as interaction prompts to help children remember how to accomplish tasks [17,34]. (ages 2-11)		
	Labels (L)	20.	Consider using audio or visual cues for prompting instead of using textual prompts [17,23,44]. (ages 2-11)		
21.		Provide audio prompts with visual support because children do not pay attention to audio prompts alone [24,29,65]. (ages 2-7)			
22.		*Choose the wording of prompting interactions to be less technical and more "kid-friendly" to understand [44]. (ages 2-7)			
Application Responsiveness	On-Touch Events (TE)	23.	*Be careful when using touchscreen terminologies such as select, pinch, and zoom for children's interfaces [44,52]. (ages 2-7)		
		24.	Provide animated prompts to help children learn what gestures to make, such as providing prompts for long-press gestures to help children remember to release their fingers after holding for a long time [34,44,66]. (ages 2-7)		
		25.	*Keep essential audio, e.g., specific interaction suggestions, at the end of the sentence, not at the beginning [58]. (ages 2-7)		
	Feedback Methods (FM)	26.	*Try utilizing time-outs after 3 to 5 seconds of inactivity to prompt children what to do next [58]. (ages 2-7)		
		27.	Provide an option to have text labels (i.e., descriptions of on-screen objects and visual metaphors) read aloud [17,24,29]. (ages 2-7)		
		28.	Provide visual or audio feedback of accepted touch input; children benefit from larger, longer visual feedback [71]. (ages 2-11)		
		29.	Use audio feedback to indicate accepted input to avoid distractions from unintended touches [17,29]. (no age specified)		
		30.	Provide auditory feedback such as an applause sounds or appreciation phrases during and after task completion [24,45]. (ages 2-7)		
		31.	Provide effective scaffolding via positive feedback to motivate children, e.g., a character that encourages them [24,45]. (ages 2-7)		
		32.	*Provide corrective feedback, such as pop-ups or dialogues offering feedback for correct and incorrect answers [10,24,30]. (ages 2-7)		
Informational Features	Tutorials (T)	33.	Avoid heavy emphasis on extrinsic rewards such as points to not overshadow intrinsic learning motivation [24,45]. (ages 2-7)		
		34.	*Provide feedback when app is busy processing so that children know to wait for something to happen [17,29]. (no age specified)		
	Instruction Format (IF)	35.	*Avoid using symbolic trackers like progress bars to track children's progress, especially for ages 4 and under [35]. (ages 2-7)		
		36.	*Create a visual illusion to help children map a symbol to its referent [35]. (ages 2-7)		
Gesture and Target Features	Types of Gestures (TG)	37.	*Use synchronous text highlighting for any text or story that is read aloud [24,58]. (ages 2-7)		
		38.	Avoid using in-app tutorials for children; the interface should provide some form of guidance during tasks [17,22]. (ages 7-11)		
		39.	Provide an option to have text instructions read aloud [17,24]. (ages 2-7)		
	Target Size (TS)	40.	*Add a complementary visual component when using audio instructions such as an animation or highlight [58]. (ages 2-7)		
41.		*Avoid using abstract concepts in children's instructions, e.g., referring to "left" and "right" portions of the screen [17,23]. (ages 2-7)			
Contextual Features	Customization (C)	42.	Avoid adding external web links [24,40]. (ages 2-7)		
		43.	Avoid gestures such as flick, drag, or pinch that are not used in the real world [6]. (ages 2-7)		
		44.	*Avoid adding the double tap gesture for children ages 5 and under, or allow a longer delay between the taps [44,58]. (ages 2-7)		
	Activity Structure (AS)	45.	*Support full-hand gestures for scrolling instead of thumb and index finger gestures, especially for ages 5 and under [26]. (ages 2-7)		
		46.	Accept partial gesture completion as children have difficulty with finger-on-screen continuity while dragging [5,58,66]. (ages 2-11)		
		47.	*Accept both single and multi-touch input for the same commands, e.g., using two or more fingers during a drag gesture should trigger the same effect as a single-finger drag gesture [66]. (ages 2-7)		
	Social (S)	48.	*Accept tap times up to 5 seconds long and target offsets of 10 millimeters for children ages 2 and above [1,66]. (ages 2-11)		
		49.	*Use horizontal scrolling instead of vertical scrolling, which is conceptually difficult for children [58]. (ages 2-7)		
		50.	*Use consistent gestures throughout the app to avoid confusion [6]. (ages 2-7)		
	Activity Structure (AS)	51.	Use gestures to manipulate objects in children's apps in a manner consistent with the object's use in the real world [6]. (ages 2-7)		
52.		Increase the active area for interface elements to allow children to avoid accidental touches to count [1,66,71]. (ages 2-11)			
53.		*Provide adequate space for interface elements to allow children to avoid accidental touches to count [1,66,71]. (ages 2-11)			
				SOCIO-EMOTIONAL	
Contextual Features	Activity Structure (AS)	54.	Provide choice and control [22,33,57]. (ages 2-11)		
		55.	Consider using an open-ended app structure to support children's engagement and creativity [42]. (ages 2-11)		
		56.	Avoid computer-automated social interactions for children, as they have no effect on their engagement [18]. (ages 7-11)		

TIDRC Framework

• Cognitive

- Visual design features
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- Informational features

• Physical

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• Socio-Emotional

Contextual features



framework is a one-sheet download

Interface Dimensions		Evidence-Based Design Recommendations		Cognitive, Physical, and Socio-Emotional Needs of Children	
Visual Design Features	Graphics (G)	1.	Be consistent with images or graphics used in the interface [6]. (ages 2-7)	COGNITIVE	
	Application Background (B)	2.	Remove visual embellishments from symbols to support children's limited capability for symbol-referent mapping [26,35]. (ages 2-7)		
	Text Font Size (F)	3.	Use child-like on-screen characters as guides or pedagogical agents to improve learning outcomes [17,24]. (ages 2-11)		
Audio Features	Types of Sound (S)	4.	*Avoid using interface designs with lots of different colors or shades [26]. (ages 2-7)		
		5.	Avoid using visually complex application backgrounds as children can get confused when interacting on them [6]. (ages 2-7)		
		6.	*Make foreground items of the interface clearer and more detailed than the background items [26,36]. (ages 2-7)		
Interactive Features	Clickable Items (CI)	7.	Use a minimum of 14-point font size to help children read faster [11]. (ages 7-11)		
		8.	*Avoid using Times font style as children report it to be significantly less easy to read [11]. (ages 7-11)		
		9.	*Make sure that every sound used in the interface has a specific meaning and function [26]. (ages 2-7)		
	Menu Complexity (M)	10.	Avoid using background music with videos, especially for children ages 5 and under [16,58]. (ages 2-7)		
		11.	Consider using narrative-style sound elements as they foster children's language development [43,65]. (ages 2-7)		
		12.	Use audio features (e.g., sound effects, vocalization) to draw attention to important content for learning purposes [16,26]. (ages 2-7)		
	Interaction Prompts (I)	13.	Visually differentiate clickable elements from the rest of the screen, e.g., use different colors or dark outlines [26,58,66]. (ages 2-7)		
		14.	*Avoid placing small interactive elements at the screen edges, especially in visually complex interface designs [71]. (ages 2-11)		
		15.	Be careful when using animated hotspots to capture children's attention as they may distract from learning [62,65]. (ages 2-11)		
	Labels (L)	16.	Limit the behavior of interactive elements to their sole purpose, e.g., avoid extraneous animations or sounds [26,65]. (ages 2-11)		
		17.	Avoid using hierarchical menus as young children may have difficulty navigating these successfully [17,23,36]. (ages 2-11)		
		18.	*Provide a means to reverse children's actions in order to support their exploratory behavior [36]. (ages 2-7)		
Application Responsiveness	On-touch events	19.	Provide explicit scaffolding such as interaction prompts to help children remember how to accomplish tasks [17,34]. (ages 2-11)		
		20.	Consider using audio or visual cues for prompting instead of using textual prompts [17,23,44]. (ages 2-11)		
		21.	Provide audio prompts with visual support because children do not pay attention to audio prompts alone [24,29,65]. (ages 2-7)		
	Feedback methods	22.	*Choose the wording of prompting interactions to be less technical and more "kid-friendly" to understand [44]. (ages 2-7)		
		23.	*Be careful when using touchscreen terminologies such as select, pinch, and zoom for children's interfaces [44,52]. (ages 2-7)		
		24.	Provide animated prompts to help children learn what gestures to make, such as providing prompts for long-press gestures to help children remember to release their fingers after holding for a long time [34,44,66]. (ages 2-7)		
	Tutorials (T)	25.	*Keep essential audio, e.g., specific interaction suggestions, at the end of the sentence, not at the beginning [58]. (ages 2-7)		
		26.	*Try utilizing time-outs after 3 to 5 seconds of inactivity to prompt children what to do next [58]. (ages 2-7)		
		27.	Provide an option to have text labels (i.e., descriptions of on-screen objects and visual metaphors) read aloud [17,24,29]. (ages 2-7)		
	Instruction Format (IF)	28.	Provide visual or audio feedback of accepted touch input; children benefit from larger, longer visual feedback [71]. (ages 2-11)		
		29.	Use audio feedback to indicate accepted input to avoid distractions from unintended touches [17,29]. (no age specified)		
		30.	Provide auditory feedback such as an applause sounds or appreciation phrases during and after task completion [24,45]. (ages 2-7)		
Informational Features	Advertisements (A)	31.	Provide effective scaffolding via positive feedback to motivate children, e.g., a character that encourages them [24,45]. (ages 2-7)		
		32.	*Provide corrective feedback, such as pop-ups or dialogues offering feedback for correct and incorrect answers [10,24,30]. (ages 2-7)		
		33.	Avoid heavy emphasis on extrinsic rewards such as points to not overshadow intrinsic learning motivation [24,45]. (ages 2-7)		
	Tutorials (T)	34.	*Provide feedback when app is busy processing so that children know to wait for something to happen [17,29]. (no age specified)		
		35.	*Avoid using symbolic trackers like progress bars to track children's progress, especially for ages 4 and under [35]. (ages 2-7)		
		36.	*Create a visual illusion to help children map a symbol to its referent [35]. (ages 2-7)		
	Instruction Format (IF)	37.	*Use synchronous text highlighting for any text or story that is read aloud [24,58]. (ages 2-7)		
		38.	Avoid using in-app tutorials for children; the interface should provide some form of guidance during tasks [17,22]. (ages 7-11)		
		39.	Provide an option to have text instructions read aloud [17,24]. (ages 2-7)		
	Advertisements (A)	40.	*Add a complementary visual component when using audio instructions such as an animation or highlight [58]. (ages 2-7)		
		41.	*Avoid using abstract concepts in children's instructions, e.g., referring to "left" and "right" portions of the screen [17,23]. (ages 2-7)		
		42.	Avoid adding external web links [24,40]. (ages 2-7)		
Gesture and Target Features	Types of Gestures (TG)	PHYSICAL			
		43.	Avoid gestures such as flick, drag, or pinch that are not used in the real world [6]. (ages 2-7)		
		44.	*Avoid adding the double tap gesture for children ages 5 and under, or allow a longer delay between the taps [44,58]. (ages 2-7)		
	Gesture Family (GF)	45.	*Support full-hand gestures for scrolling instead of thumb and index finger gestures, especially for ages 5 and under [26]. (ages 2-7)		
		46.	Accept partial gesture completion as children have difficulty with finger-on-screen continuity while dragging [5,58,66]. (ages 2-11)		
		47.	*Accept both single and multi-touch input for the same commands, e.g., using two or more fingers during a drag gesture should trigger the same effect as a single-finger drag gesture [66]. (ages 2-7)		
	Target Size (TS)	48.	*Accept tap times up to 5 seconds long and target offsets of 10 millimeters for children ages 2 and above [1,66]. (ages 2-11)		
		49.	*Use horizontal scrolling instead of vertical scrolling, which is conceptually difficult for children [58]. (ages 2-7)		
		50.	*Use consistent gestures throughout the app to avoid confusion [6]. (ages 2-7)		
	Customization (C)	51.	Use gestures to manipulate objects in children's apps in a manner consistent with the object's use in the real world [6]. (ages 2-7)		
		52.	Increase the active area for interface elements to allow children to avoid accidental touches to count [1,66,71]. (ages 2-11)		
		53.	*Provide adequate space between interface elements to avoid accidental touches to count [1,66,71]. (ages 2-11)		
Contextual Features	Activity Structure (AS)	SOCIO-EMOTIONAL			
		54.	Provide choice and control [22,33,57]. (ages 2-11)		
		55.	Consider using an open-ended app structure to support children's engagement and creativity [42]. (ages 2-11)		
	Social (S)	56.	Avoid computer-automated social interactions for children, as they have no effect on their engagement [18]. (ages 7-11)		
		57.	*Provide an option for children to credit each other, rather than using automated means of acknowledgment [46]. (ages 7-11)		

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• Cognitive

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Contextual features



Interface Dimensions		Evidence-Based Design Recommendations		Cognitive, Physical, and Socio-Emotional Needs of Children		
Visual Design Features	Graphics (G)	1.	Be consistent with images or graphics [6]. (ages 2-7)	2.	Remove visual embellishments from symbols to support children's limited capability for symbol-referent mapping [26,35]. (ages 2-7)	
	Application Background (B)	3.	Use child-like on-screen characters as guides or pedagogical agents to improve learning outcomes [17,24]. (ages 2-11)	4.	Avoid using interface designs with lots of different colors or shades [26]. (ages 2-7)	
	Text Font Size (F)	5.	Avoid using visually complex application backgrounds as children can get confused when interacting on them [6]. (ages 2-7)	6.	Make foreground items of the interface clearer and more detailed than the background items [26,36]. (ages 2-7)	
Audio Features	Types of Sound (S)	7.	Use a minimum of 14-point font size to help children read faster [11]. (ages 7-11)	8.	Avoid using Times font style as children report it to be significantly less easy to read [11]. (ages 7-11)	
		9.	Make sure that every sound used in the interface has a specific meaning and function [26]. (ages 2-7)	10.	Avoid using background music with videos, especially for children ages 5 and under [16,58]. (ages 2-7)	
Interactive Features	Clickable Items (CI)	11.	Consider using narrative-style sound elements as they foster children's language development [43,65]. (ages 2+)	12.	Use audio features (e.g., sound effects, vocalization) to draw attention to important content for learning purposes [16,26]. (ages 2-7)	
		13.	Visually differentiate clickable elements from the rest of the screen, e.g., use different colors or dark outlines [26,58,66]. (ages 2-7)	14.	Avoid placing small interactive elements at the screen edges, especially in visually complex interface designs [71]. (ages 2-11)	
	Menu Complexity (M)	15.	Be careful when using animated hotspots to capture children's attention as they may distract from learning [62,65]. (ages 2-11)	16.	Limit the behavior of interactive elements to their sole purpose, e.g., avoid extraneous animations or sounds [26,65]. (ages 2-11)	
		17.	Avoid using hierarchical menus as young children may have difficulty navigating these successfully [17,23,36]. (ages 2-11)	18.	Provide a means to reverse children's actions in order to support their exploratory behavior [36]. (ages 2-7)	
	Interaction prompts	19.	Provide explicit scaffolding such as interaction prompts to help children remember how to accomplish tasks [17,34]. (ages 2-11)	20.	Consider using audio or visual cues for prompting instead of using textual prompts [17,23,44]. (ages 2-11)	
		21.	Provide audio prompts with visual support because children do not pay attention to audio prompts alone [24,29,65]. (ages 2-7)	22.	Choose the wording of prompting interactions to be less technical and more "kid-friendly" to understand [44]. (ages 2-7)	
		23.	Be careful when using touchscreen terminologies such as select, pinch, and zoom for children's interfaces [44,52]. (ages 2-7)	24.	Provide animated prompts to help children learn what gestures to make, such as providing prompts for long-press gestures to help children remember to release their fingers after holding for a long time [34,44,66]. (ages 2-7)	
		25.	Keep essential audio, e.g., specific interaction suggestions, at the end of the sentence, not at the beginning [58]. (ages 2-7)	26.	Try utilizing time-outs after 3 to 5 seconds of inactivity to prompt children what to do next [58]. (ages 2-7)	
	Labels (L)	27.	Provide an option to have text labels (i.e., descriptions of on-screen objects and visual metaphors) read aloud [17,24,29]. (ages 2-7)	28.	Provide visual or audio feedback of accepted touch input; children benefit from larger, longer visual feedback [71]. (ages 2-11)	
	Application Responsiveness	On-Touch Events (TE)	29.	Use audio feedback to indicate accepted input to avoid distractions from unintended touches [17,29]. (no age specified)	30.	Provide auditory feedback such as an applause sounds or appreciation phrases during and after task completion [24,45]. (ages 2-7)
Feedback Methods (FM)		31.	Provide effective scaffolding via positive feedback to motivate children, e.g., a character that encourages them [24,45]. (ages 2-7)	32.	Provide corrective feedback, such as pop-ups or dialogues offering feedback for correct and incorrect answers [10,24,30]. (ages 2-7)	
		33.	Avoid heavy emphasis on extrinsic rewards such as points to not overshadow intrinsic learning motivation [24,45]. (ages 2-7)	34.	Provide feedback when app is busy processing so that children know to wait for something to happen [17,29]. (no age specified)	
		35.	Avoid using symbolic trackers like progress bars to track children's progress, especially for ages 4 and under [35]. (ages 2-7)	36.	Create a visual illusion to help children map a symbol to its referent [35]. (ages 2-7)	
Informational Features	Tutorials (T)	37.	Use synchronous text highlighting for any text or story that is read aloud [24,58]. (ages 2-7)	38.	Avoid using in-app tutorials for children; the interface should provide some form of guidance during tasks [17,22]. (ages 7-11)	
	Instruction Format (IF)	39.	Provide an option to have text instructions read aloud [17,24]. (ages 2-7)	40.	Add a complementary visual component when using audio instructions such as an animation or highlight [58]. (ages 2-7)	
		41.	Avoid using abstract concepts in children's instructions, e.g., referring to "left" and "right" portions of the screen [17,23]. (ages 2-7)	42.	Avoid adding external web links [24,40]. (ages 2-7)	
	Advertisements (A)					
Gesture and Target Features	Types of gestures	43.	Avoid gestures such as flick, drag, or pinch [44,58]. (ages 2-7)	44.	Avoid adding the double tap gesture for children ages 5 and under, or allow a longer delay between the taps [44,58]. (ages 2-7)	
		45.	Support full-hand gestures for scrolling instead of thumb and index finger gestures, especially for ages 5 and under [26]. (ages 2-7)	46.	Accept partial gesture completion as children have difficulty with finger-on-screen continuity while dragging [5,58,66]. (ages 2-11)	
		47.	Accept both single and multi-touch input for the same commands, e.g., using two or more fingers during a drag gesture should trigger the same effect as a single-finger drag gesture [66]. (ages 2-7)	48.	Accept tap times up to 5 seconds long and target offsets of 10 millimeters for children ages 2 and above [1,66]. (ages 2-11)	
	Gesture Family (GF)	49.	Use horizontal scrolling instead of vertical scrolling, which is conceptually difficult for children [58]. (ages 2-7)	50.	Use consistent gestures throughout the app to avoid confusion [6]. (ages 2-7)	
		Target Size (TS)	51.	Use gestures to manipulate objects in children's apps in a manner consistent with the object's use in the real world [6]. (ages 2-7)	52.	Increase the active area for interface elements to allow children to avoid accidental touches to count [1,66,71]. (ages 2-11)
			53.	Provide adequate space for interface elements to allow children to avoid accidental touches to count [1,66,71]. (ages 2-11)	54.	Provide adequate space for interface elements to allow children to avoid accidental touches to count [1,66,71]. (ages 2-11)
Contextual Features	Customization (C)	55.	Provide choice and control [42]. (ages 2-11)	56.	Consider using an open-ended app structure to support children's engagement and creativity [42]. (ages 2-11)	
	Activity Structure (AS)	57.	Avoid computer-automated social interactions for children, as they have no effect on their engagement [18]. (ages 7-11)	58.	Provide an option for children to credit each other, rather than using automated means of acknowledgment [46]. (ages 7-11)	
	Social (S)					

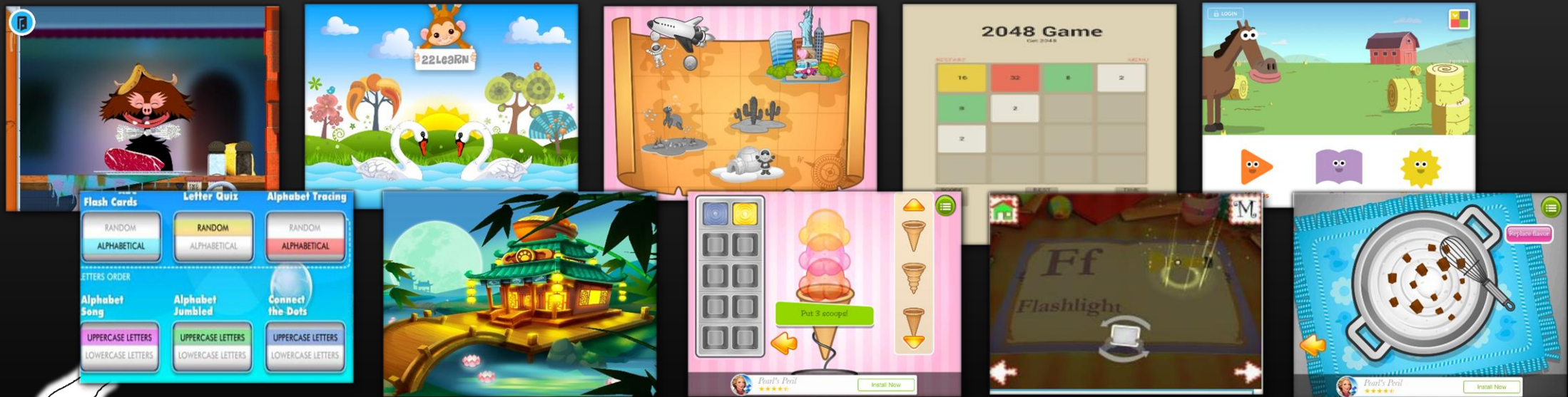
PHYSICAL

SOCIO-EMOTIONAL

framework is a one-sheet download

Empirical Analysis of Existing Apps

- 50 popular free iPad apps
- “Kids” category: games (56%) and education (44%)
- Ages targeted: 5 and under (58% of apps), 6 to 9 (28%), 9 to 11 (10%)



Qualitative Coding

Developmental Category	Coding Dimension
Cognitive	Visual Design Features: Graphics, Application Background, Text Font Size
	Audio Features: Types of Sound
	Interactive Features: Clickable Items, Menu Complexity, Interaction Prompts, Labels
	Application Responsiveness: On-Touch Events, Feedback Methods
	Informational Features: Tutorials, Instruction Format, Advertisements
Physical	Gesture and Target Features: Type of Gestures, Gesture Family, Target Size
Socio-Emotional	Contextual Features: Customization, Activity Structure, Social Sharing and Privacy



Qualitative Coding

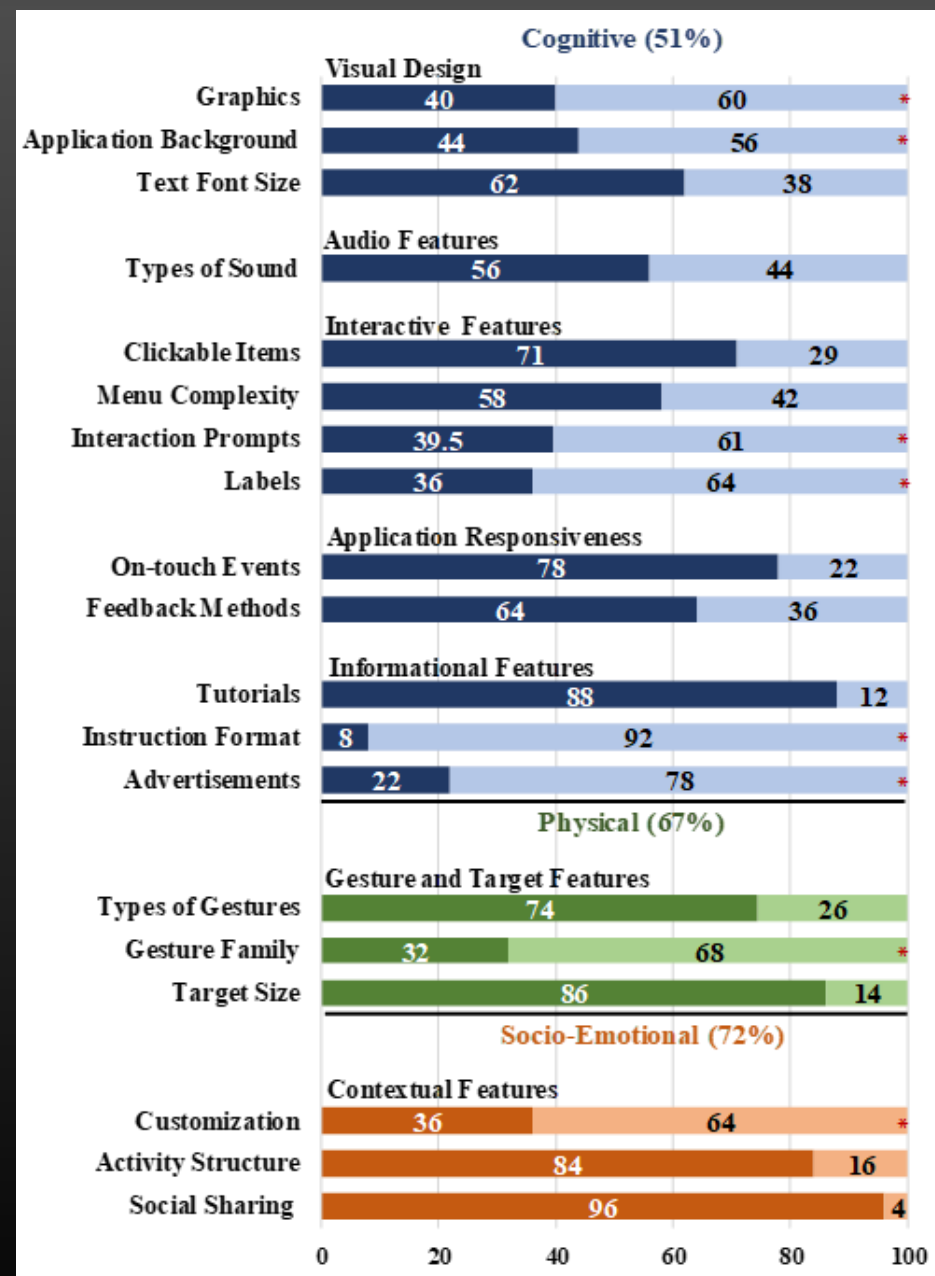
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Overall Findings

- 51% of apps were consistent with **cognitive** recommendations
- 67% of apps were consistent with **physical** recommendations
- 72% of apps were consistent with **socio-emotional** recommendations

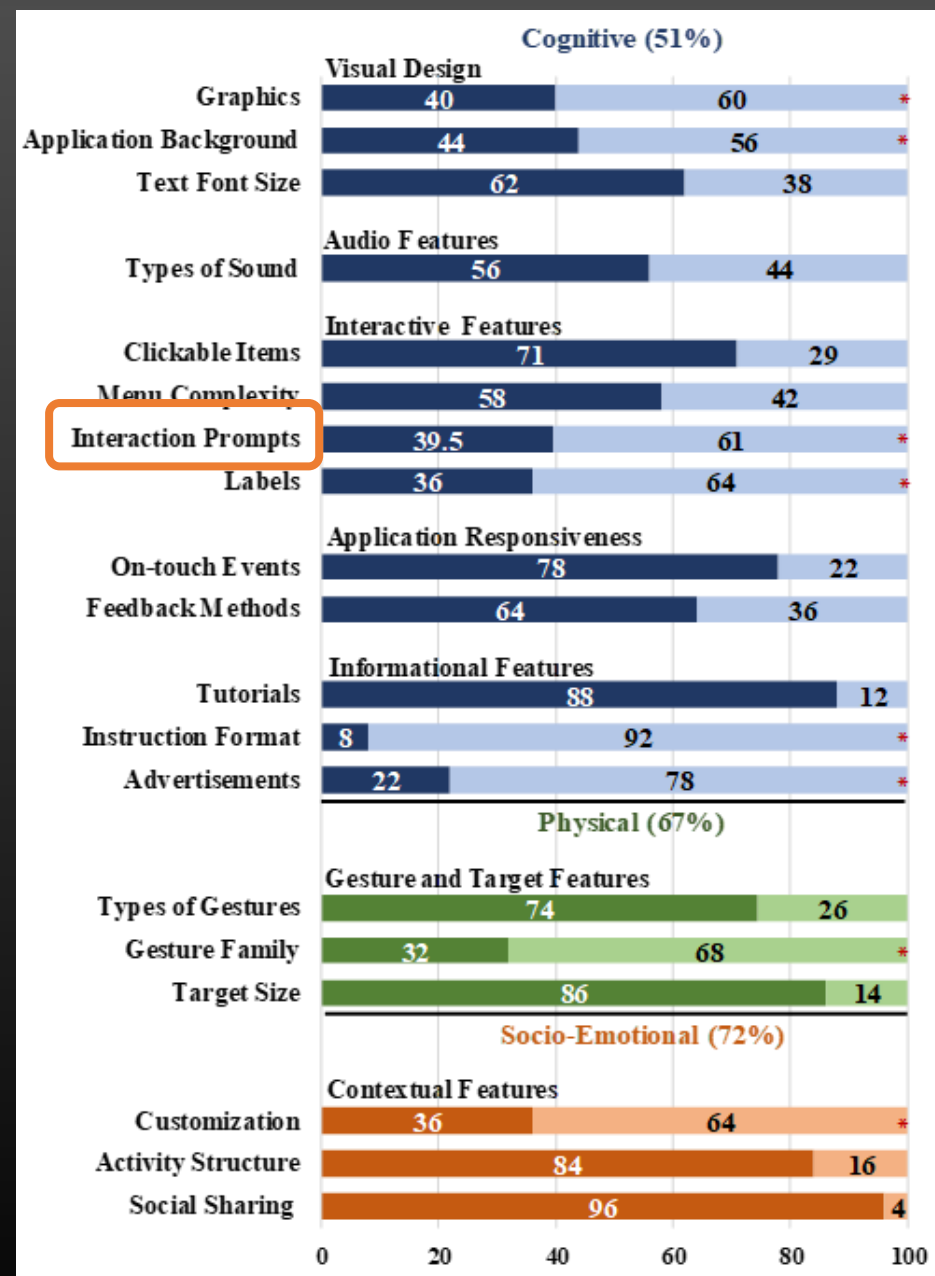


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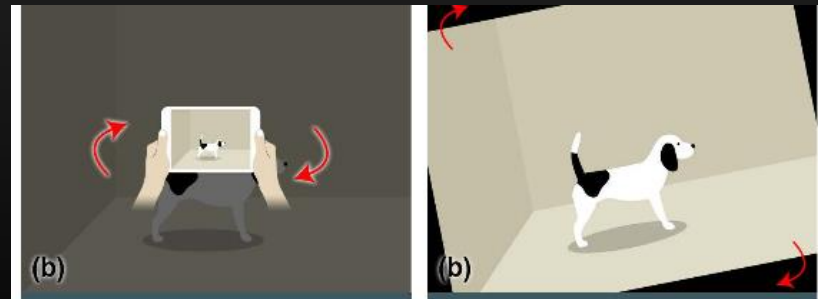


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Example: Cognitive: **Interaction Prompts**

- Types of interaction prompts:
 - Audio prompts, e.g., in-app voice recordings
 - Static visual (text) prompts
 - Animated hand prompts
 - Animated visual prompts

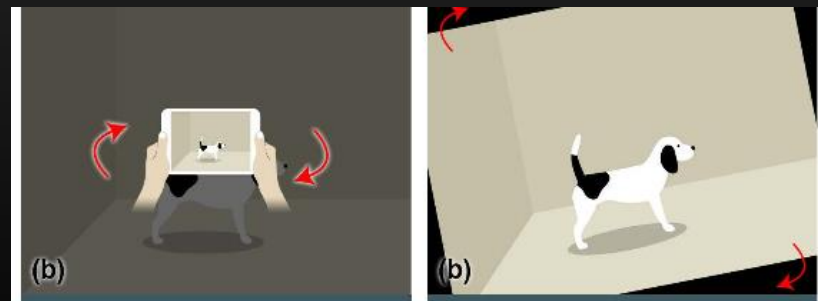


*Animated hand prompts vs Animated visual prompts**

**Hiniker et al, IDC 2015 [34]*

Example: Cognitive: **Interaction Prompts**

- I19, TIDRC: Provide explicit scaffolding such as interaction prompts to help children remember how to accomplish tasks [17,34]:
 - **54% of apps included interaction prompts to guide children [ages 2-11].**
- I24, TIDRC: Provide animated prompts to help children learn what gestures to make... [34,44,66]:
 - **32% of apps followed this recommendation [ages 2-7].**



*Animated hand prompts vs Animated visual prompts**

**Hiniker et al, IDC 2015 [34]*

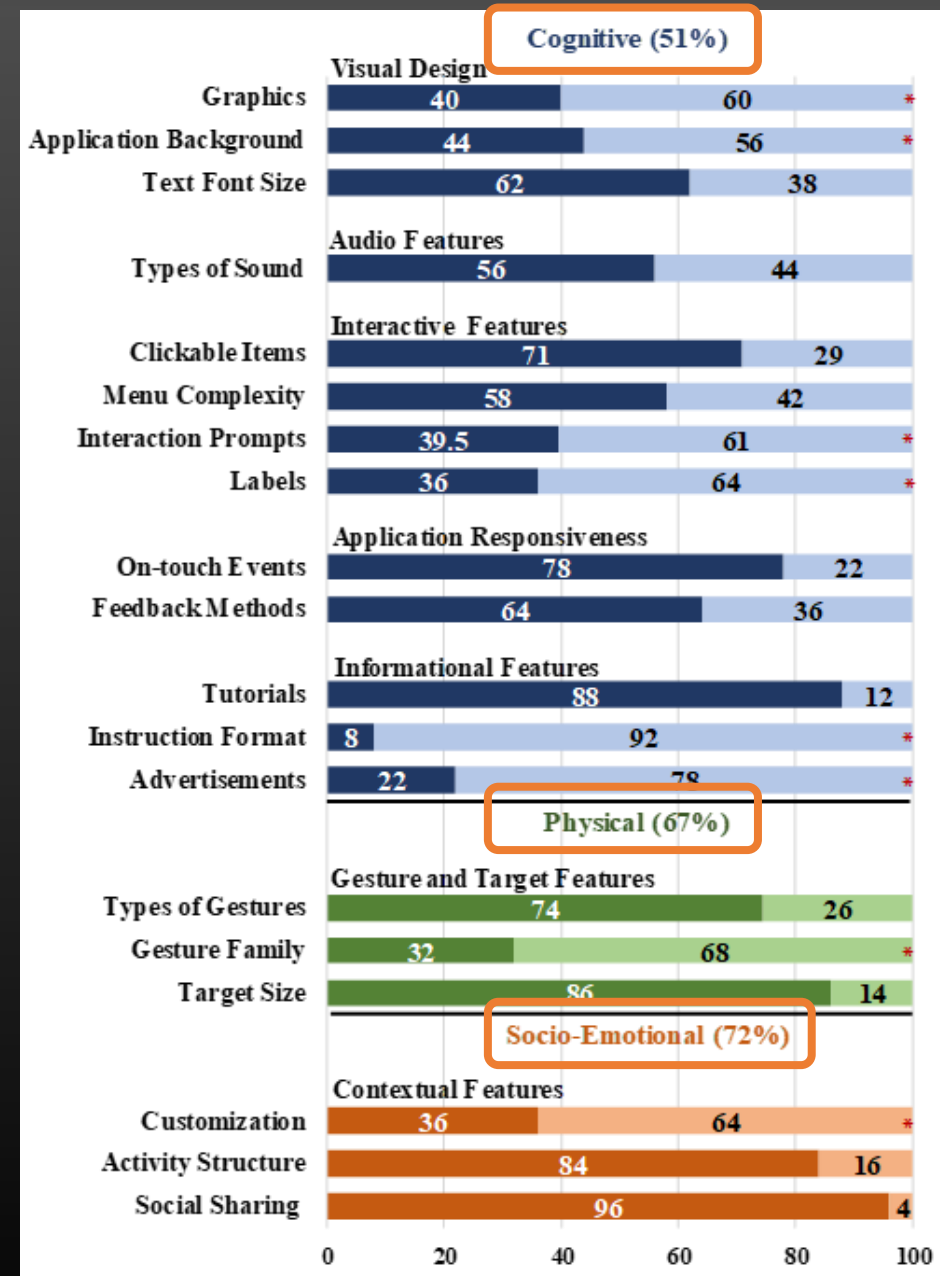
Take-Aways

1. Research-practice gap
2. Conflicting guidelines
3. Socio-emotional needs
4. Closing the research-practice gap



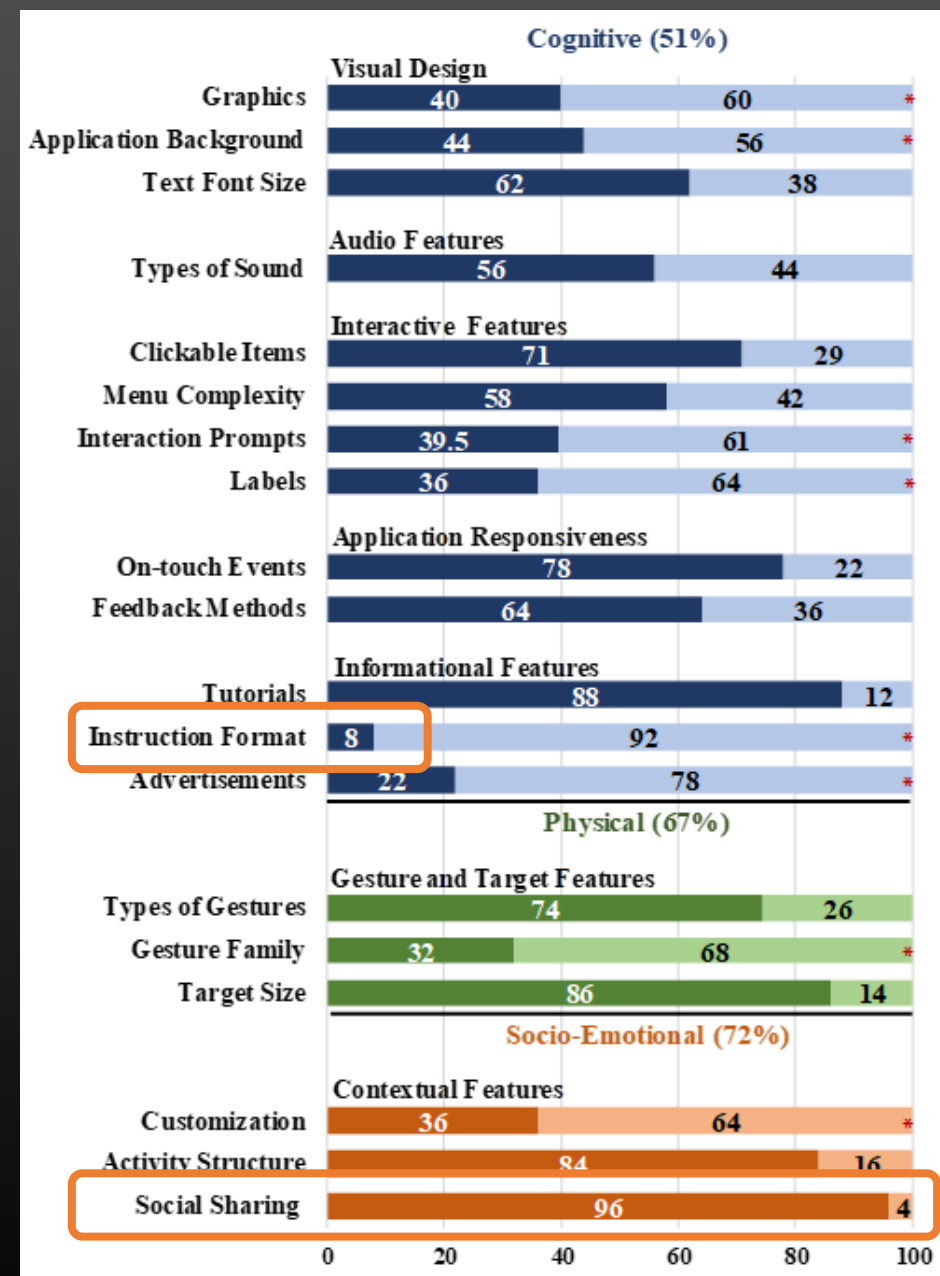
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Physical (67%)
Socio-emotional (72%)
- **Motor** abilities of children are well-supported (physical).
- **Cognitive** abilities are less well-supported.



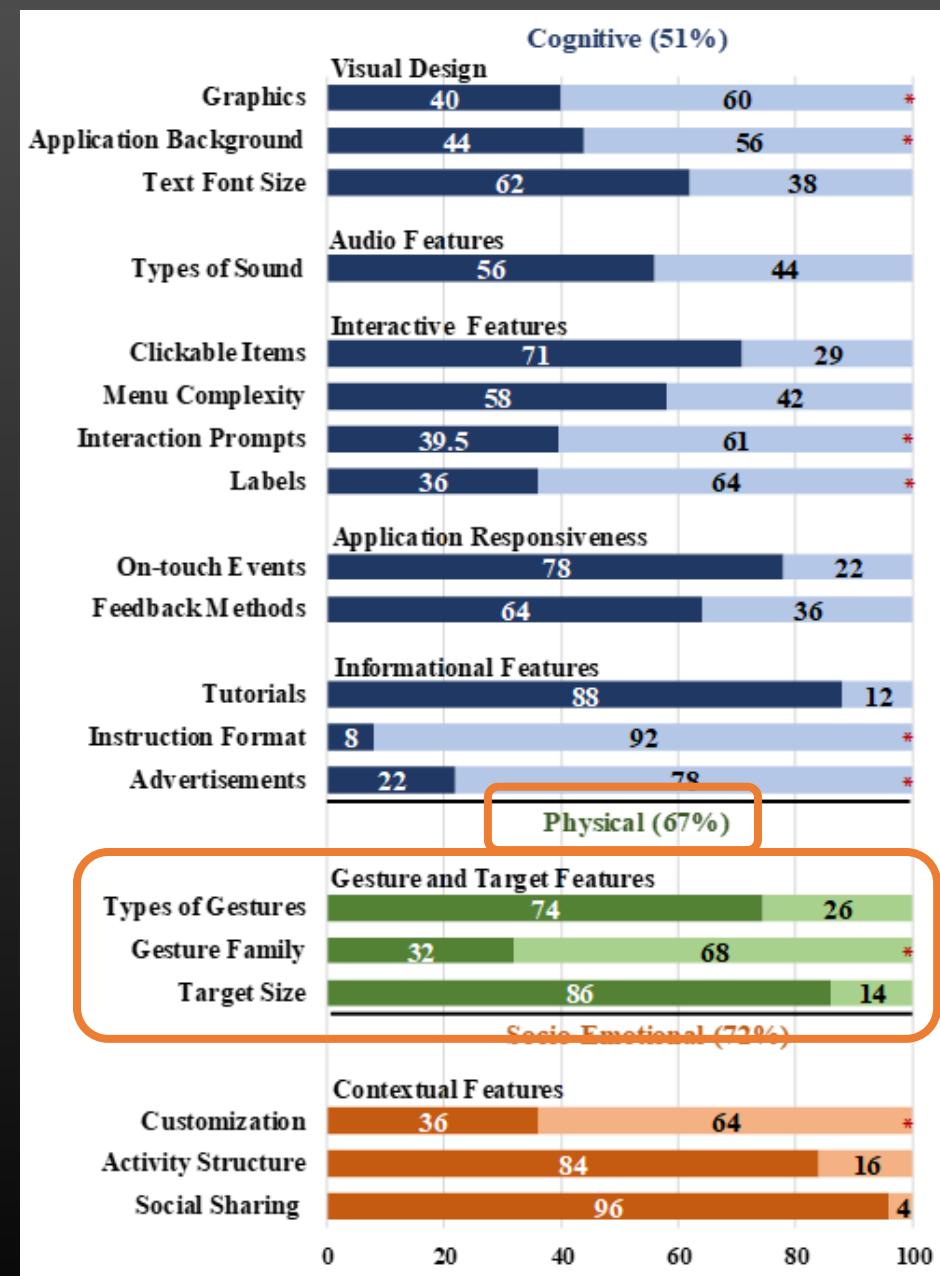
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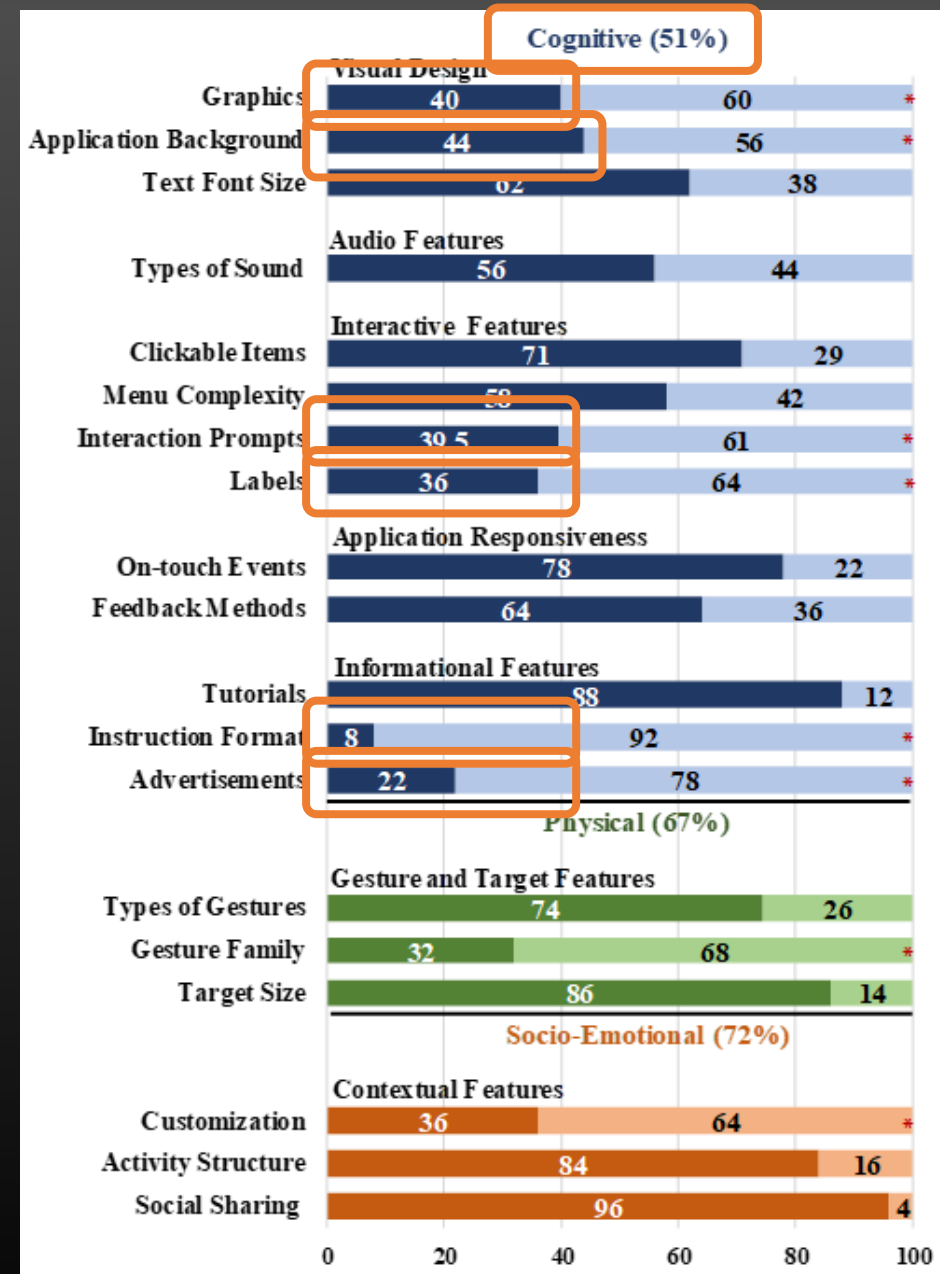
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1. Research-practice gap

Take-away: without addressing this gap by making relevant design guidelines accessible to practitioners, children's touchscreen apps may, at best, be abandoned for lack of ability to use them, and, at worst, hinder children's development by ignoring opportunities for design.



2. Conflicting guidelines

- Not all empirical evidence was consistent with each other!

Recommendation:	Found a feature “worked”:	Found a feature did not “work”:
Types of gestures	Nacher et al IJHCS 2015 [47]	Aziz IJCIT 2013 [5]
Clickable items	Hanna et al’s book [29]	Gelman’s book [26]
Activity Structure	Kucirkova et al Comp & Ed 2014 [42]	Hanna et al’s book [42]

- We **did not recommend a feature** if any studies showed that children may have problems with some features, since this means the feature is not likely to work well for all children.



2. Conflicting guidelines

Take-away: these areas of conflicting evidence are important directions for future research to clarify and seek convergence to create solid recommendations for multiple age groups.



3. Socio-emotional needs

- While 72% of apps followed recommendations for supporting children's socio-emotional needs, only **four recommendations** (out of 57) pertained to this developmental category at all.
- Other types of research could be relevant to TIDRC, including apps designed for **parent-child dyadic use** or **children's interactive media**.
 - How can these apply to touchscreen app contexts?
- Social computing and novel interaction research communities tend to be disconnected within SIGCHI (Bernstein, CHI EA 2011).



3. Socio-emotional needs

Take-away: we call for the social computing and systems research communities to work together toward the larger goal of holistic design for children's range of developmental needs.



4. Closing the research-practice gap

- **Leverage conceptual frameworks** (like TIDRC)
 - Create accessible frameworks and keep them updated
 - Send us your research to add to TIDRC!
- Translate research findings into **actionable design guidelines**
 - Use language like “use” or “avoid” to make clear what designers should do
- **Disseminate research findings more broadly**
 - Don’t solely publish in academic communities
 - Consider: UXPA Magazine*, SIGCHI Bulletin, CSCW Blog, etc.
 - Participate in bridging workshops and public scholarship efforts



*Anthony, Kientz, & Hiniker, UXPA Mag 2018 [2]

4. Closing the research-practice gap

**Take-away: we publicly release the TIDRC framework guide as a one-sheet download for researchers and practitioners to easily access:
<https://init.cise.ufl.edu/tidrc/>**



Thank you!

- Download the TIDRC framework here: <https://init.cise.ufl.edu/tidrc/>
 - Contact us if you have new research to add to it!



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