Comparing informativeness of an NLG chatbot vs graphical app in diet-information domain

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- Past research inspected **static contexts** only (no interaction; fixed presentation).

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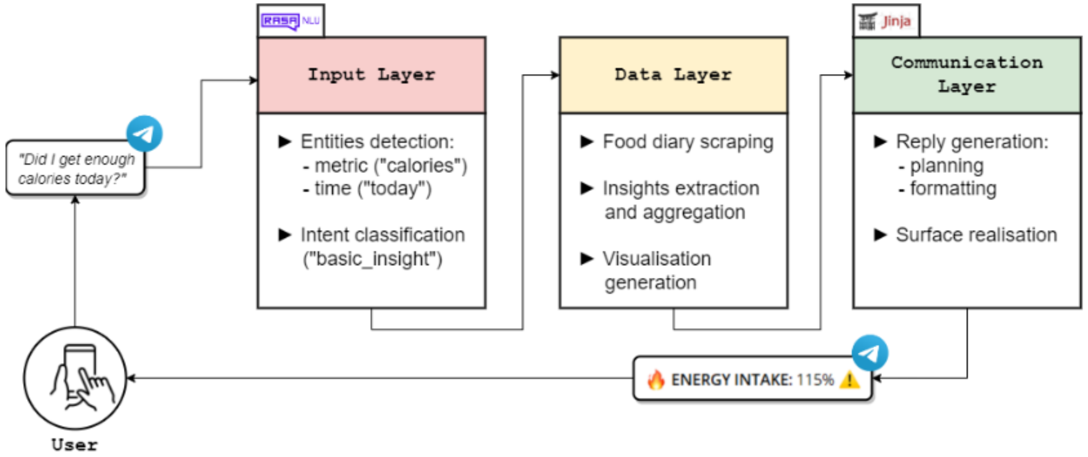

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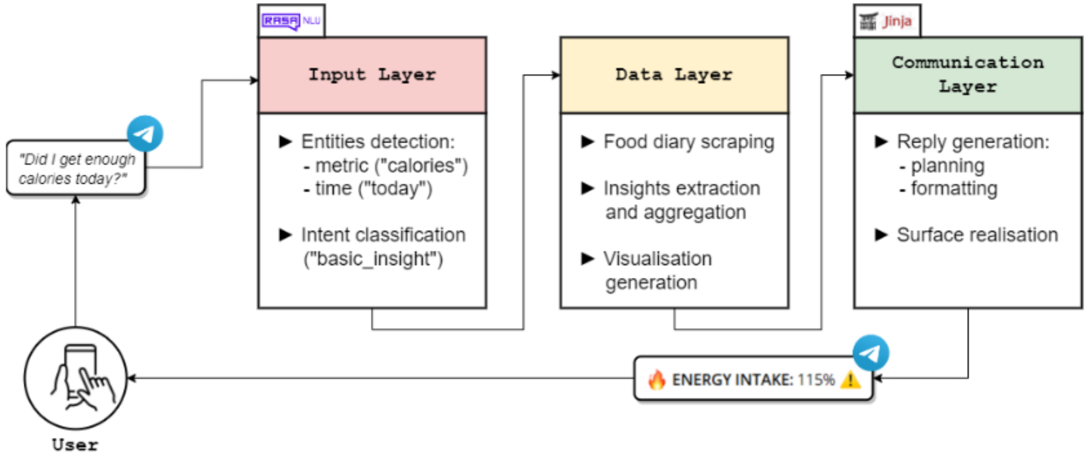

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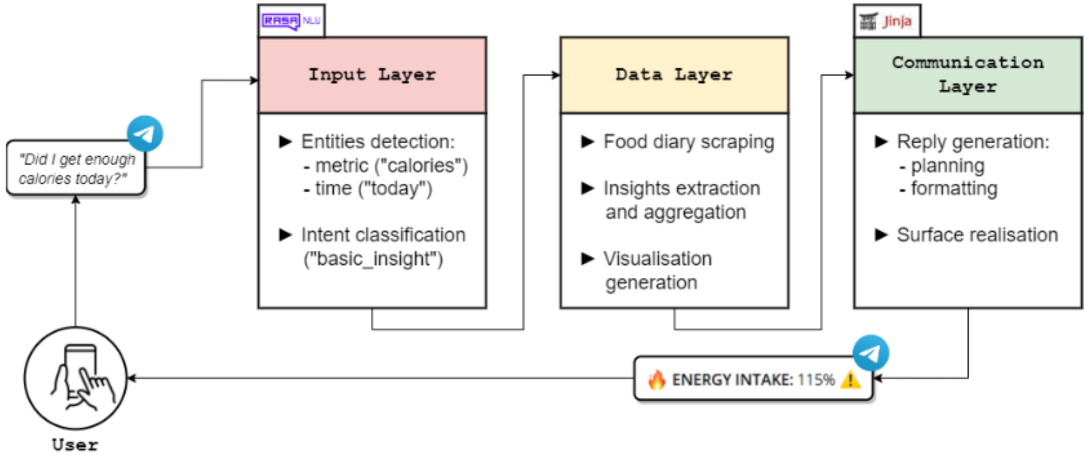

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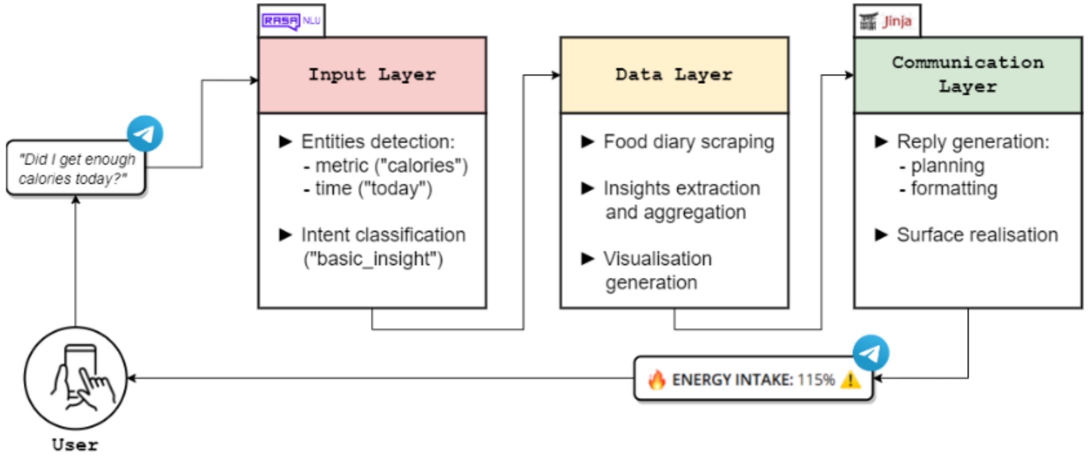

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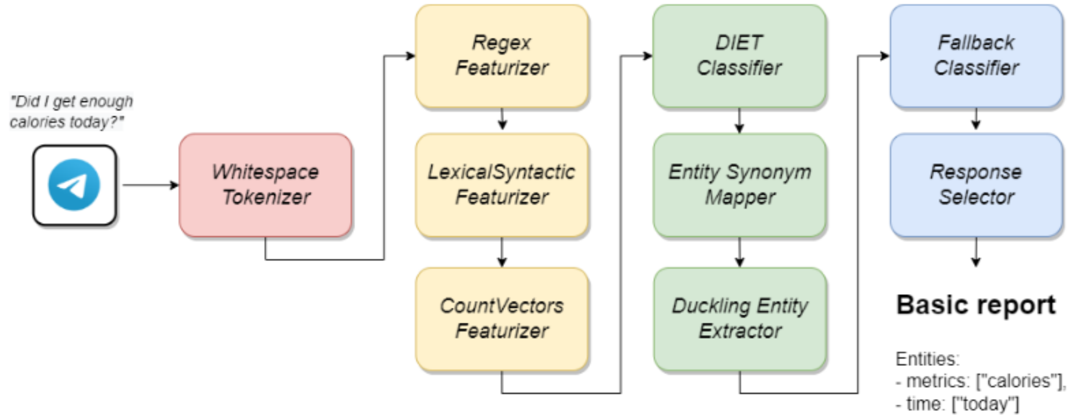

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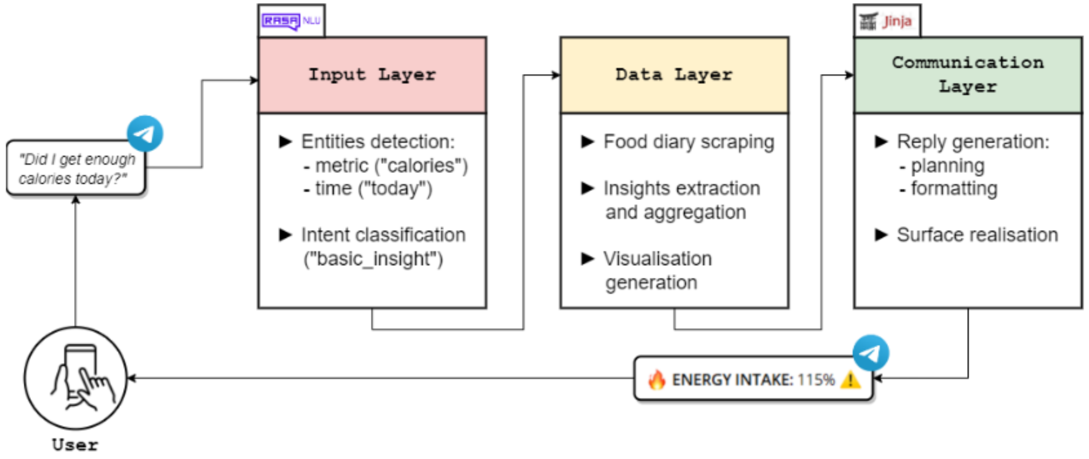

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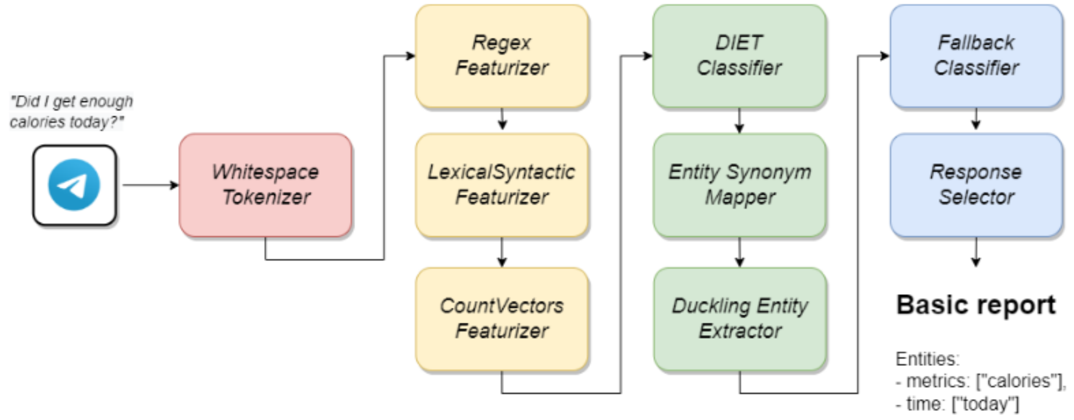

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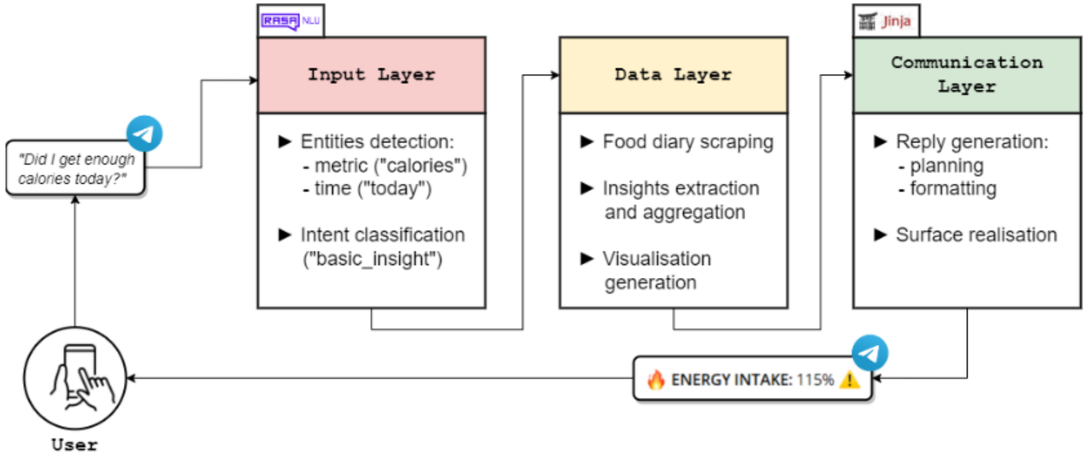

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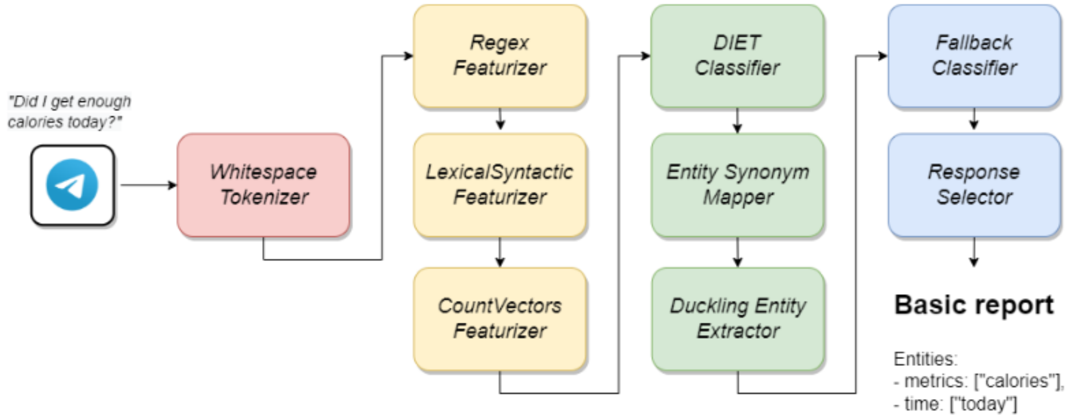

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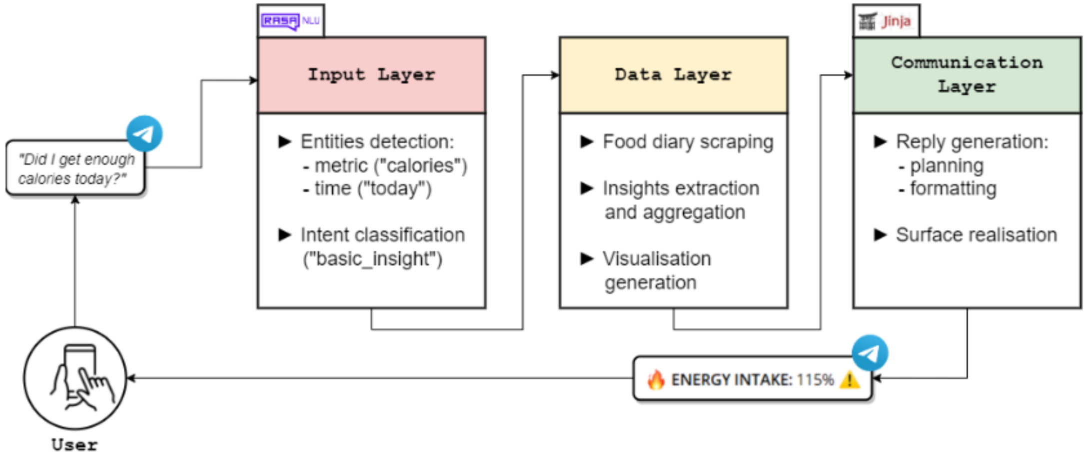

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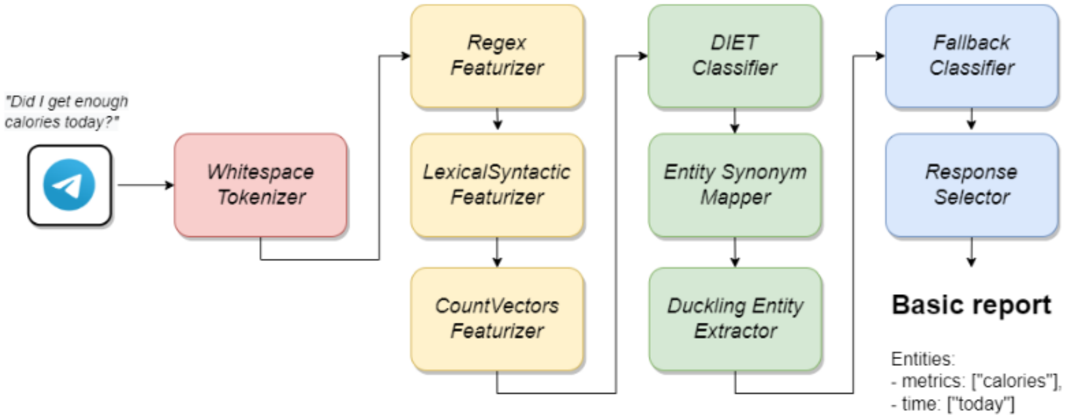

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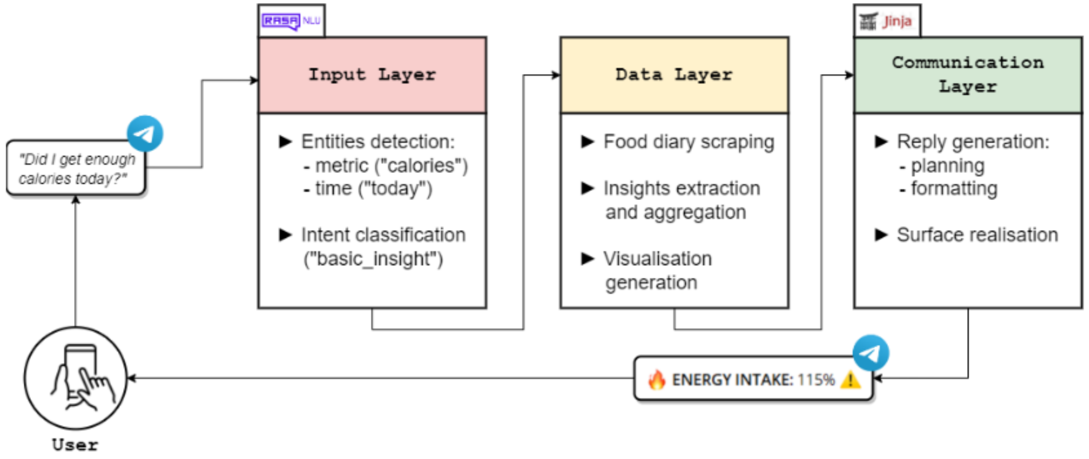

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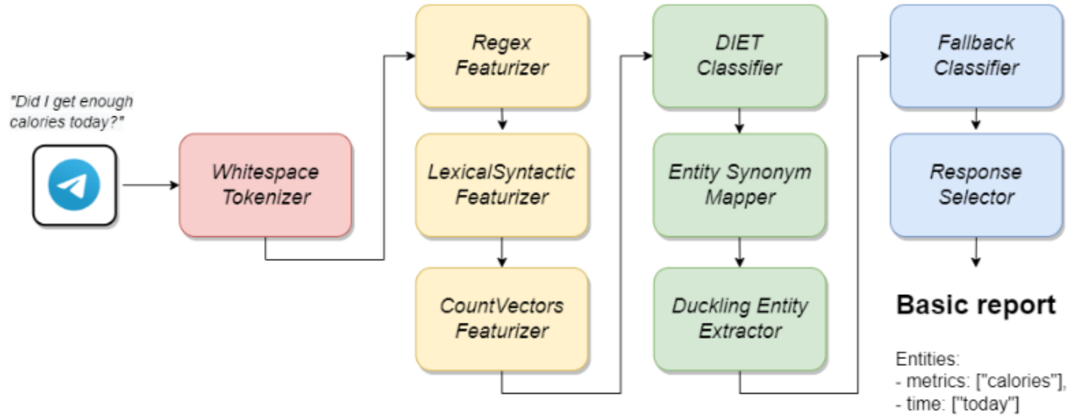

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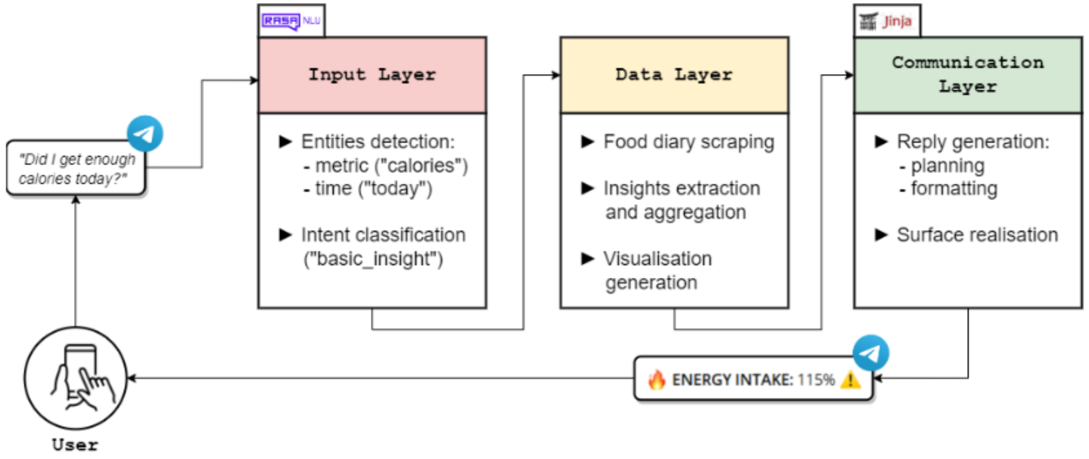
  - Existing dieting apps adopt poor communication (**Balloccu et al., 2021; Balloccu and Reiter, 2022**)



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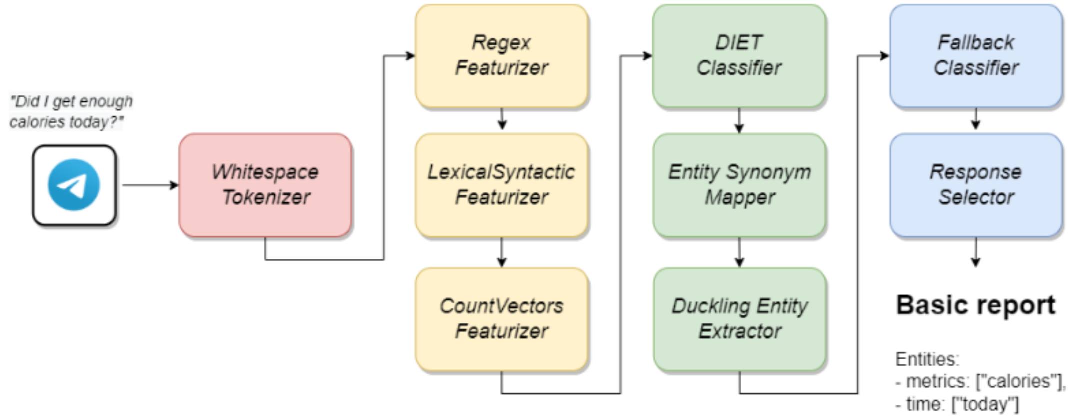

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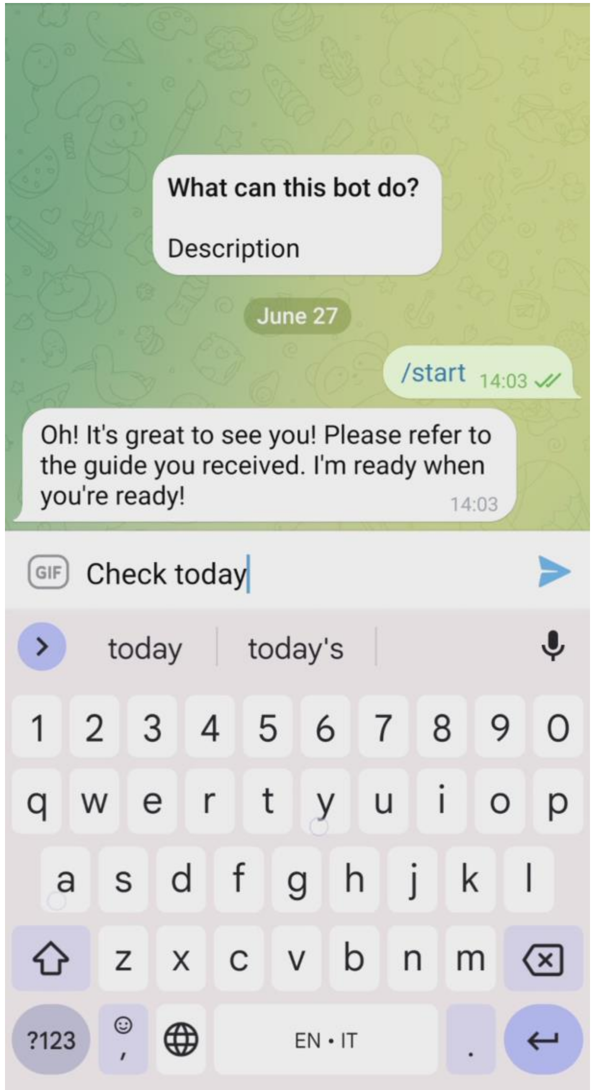

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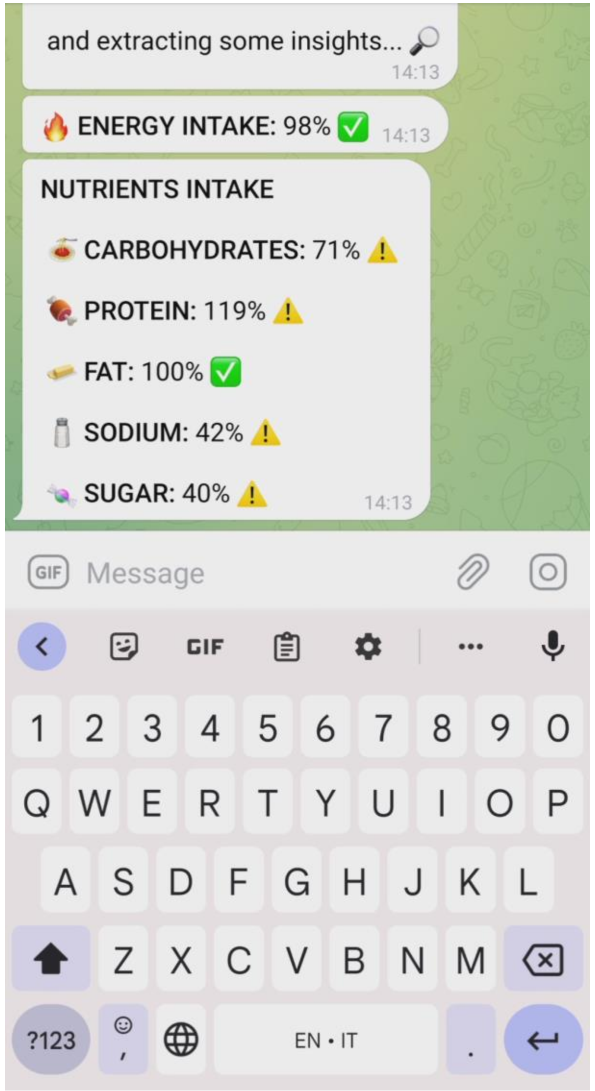

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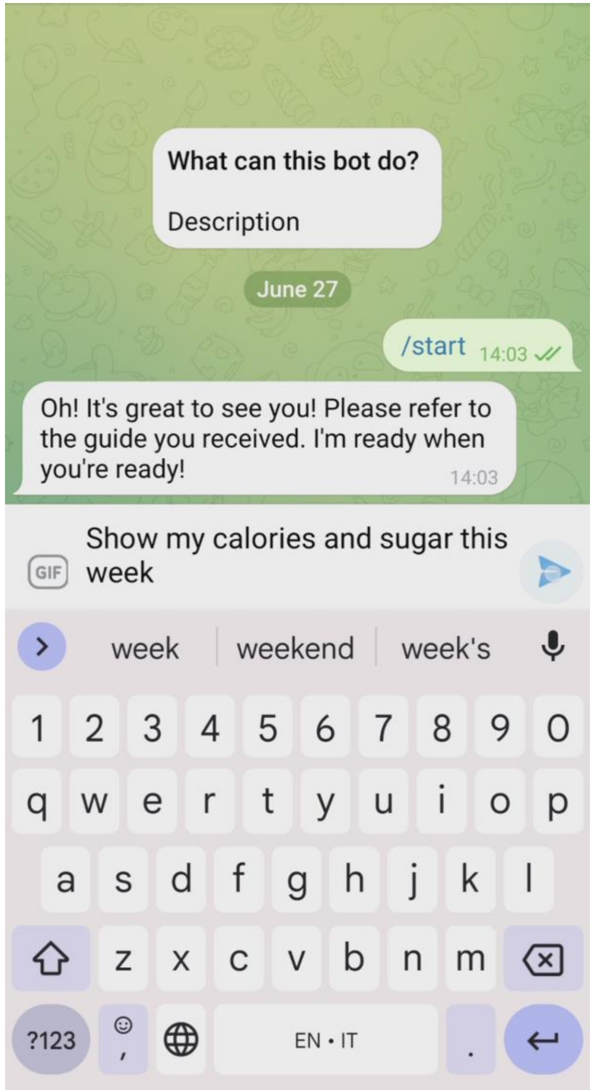

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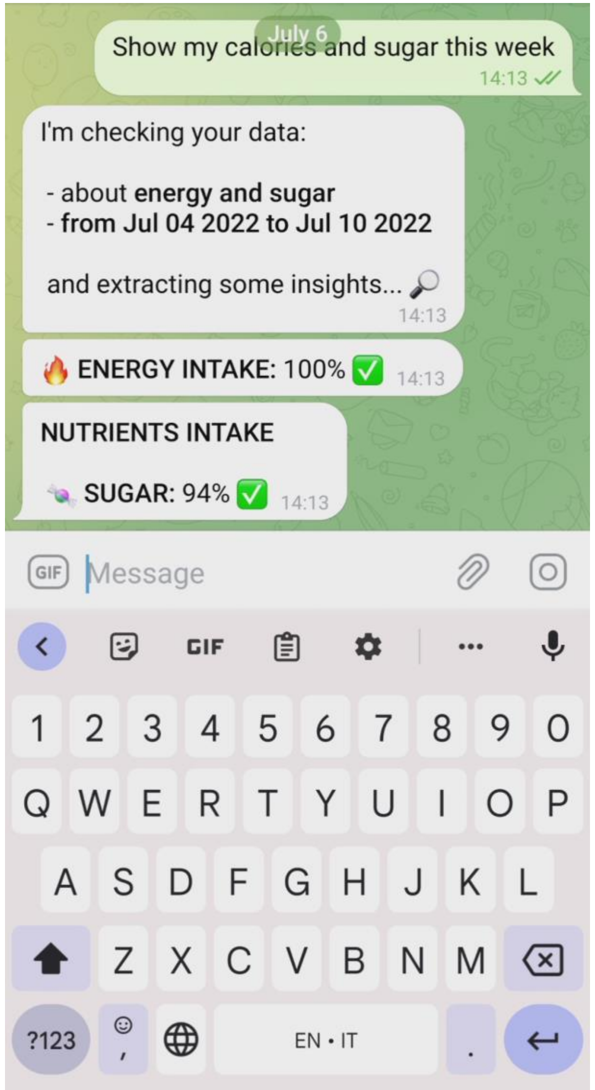

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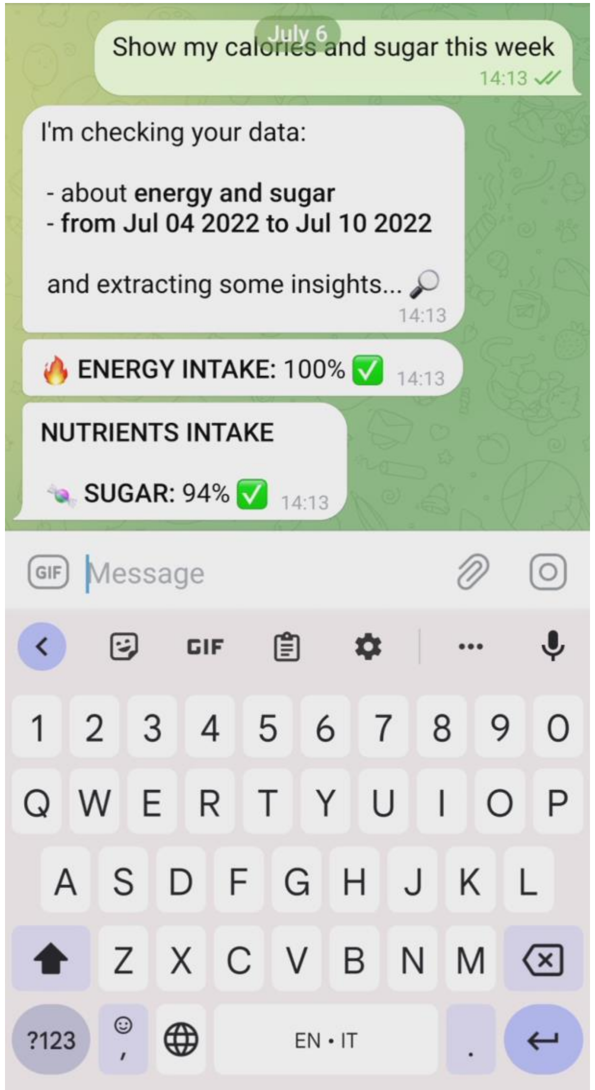

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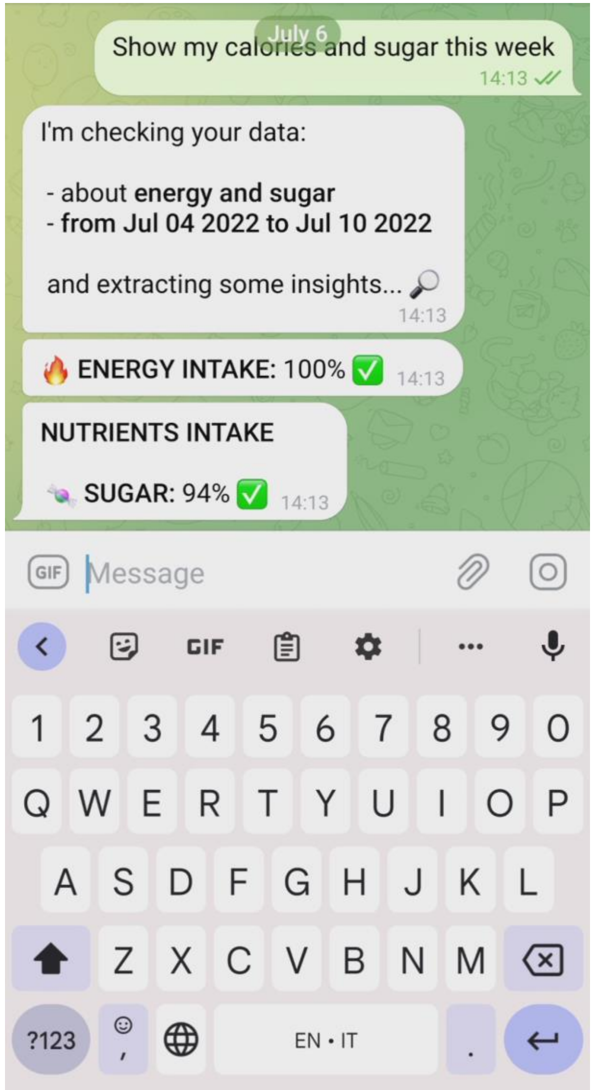

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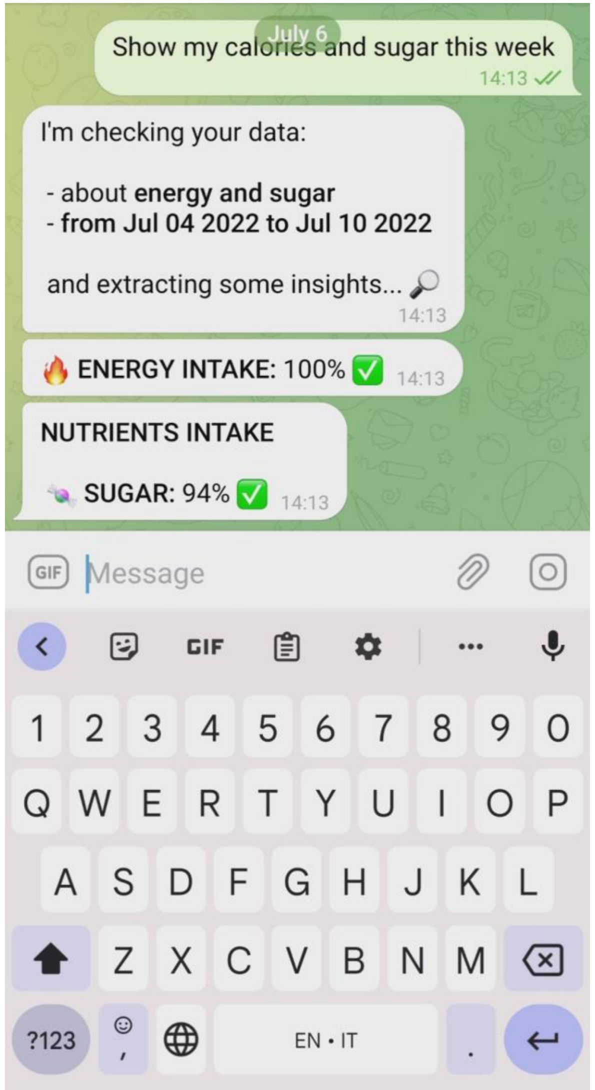

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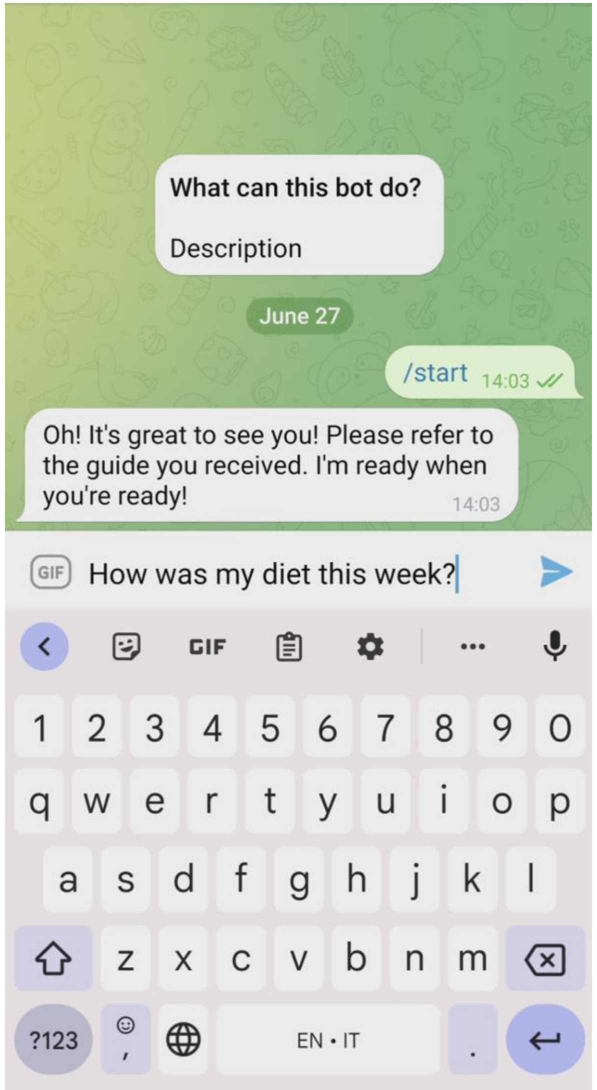

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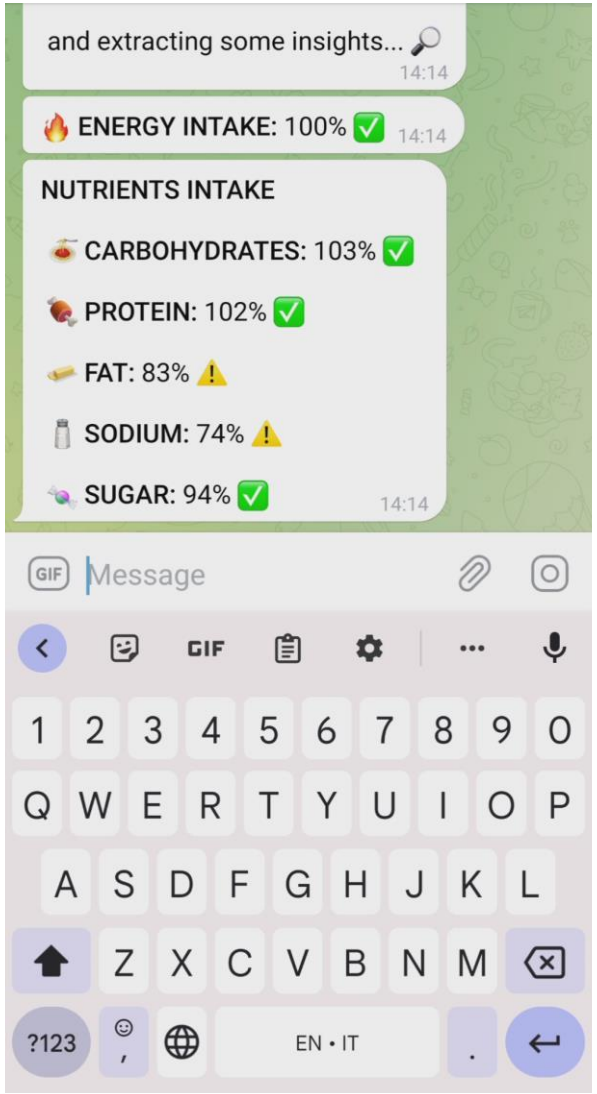

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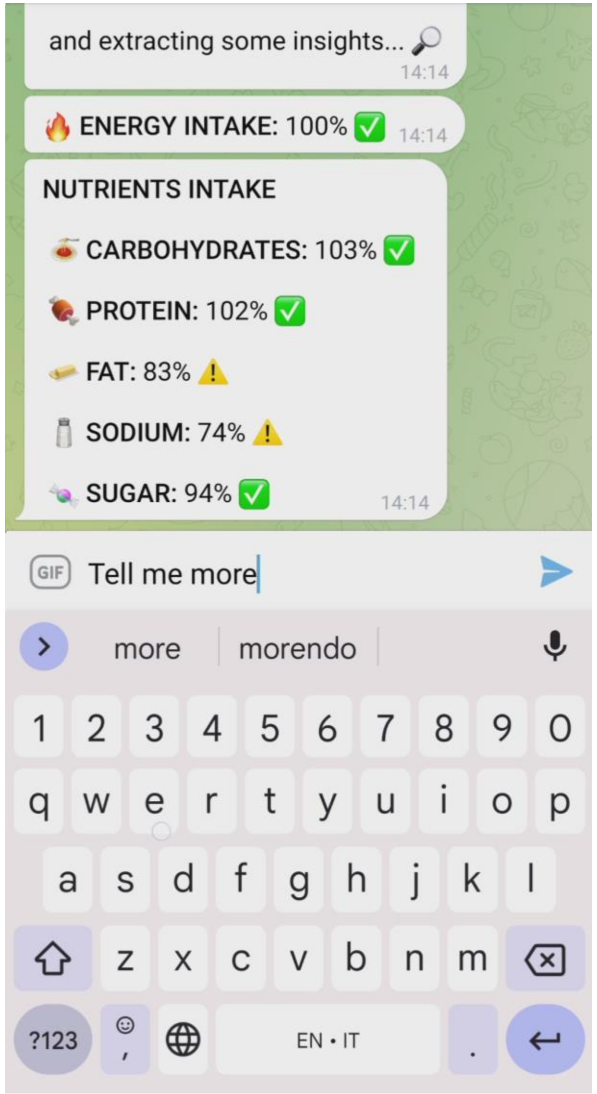

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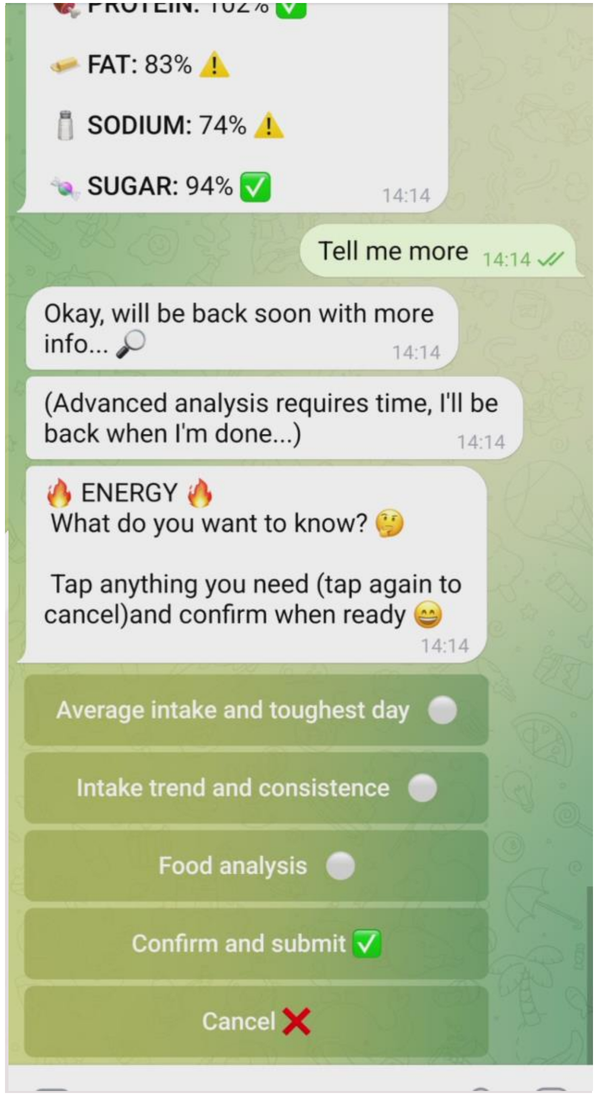

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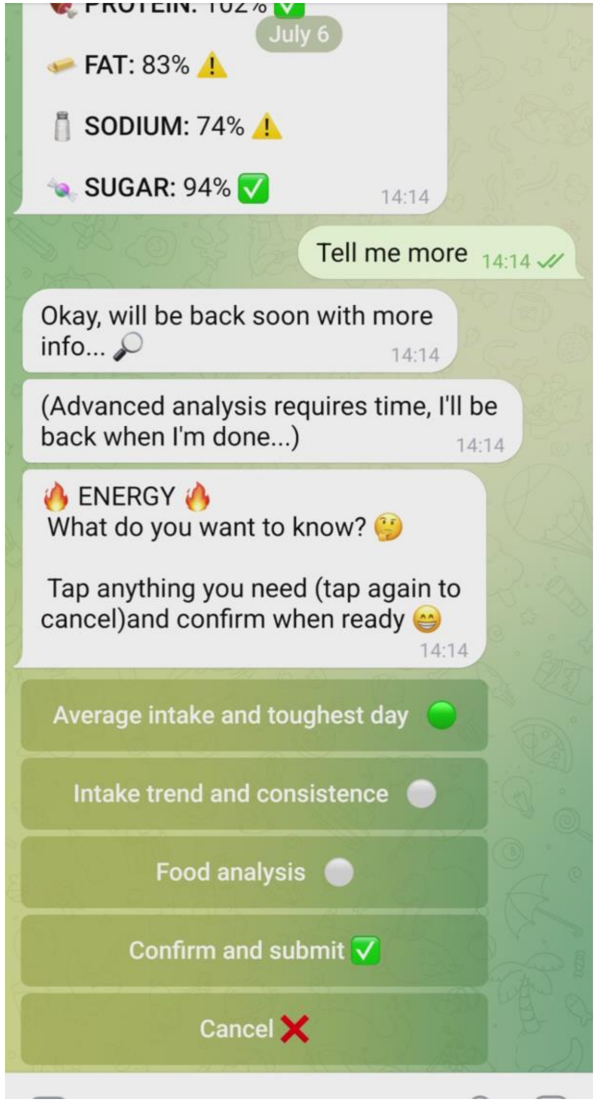

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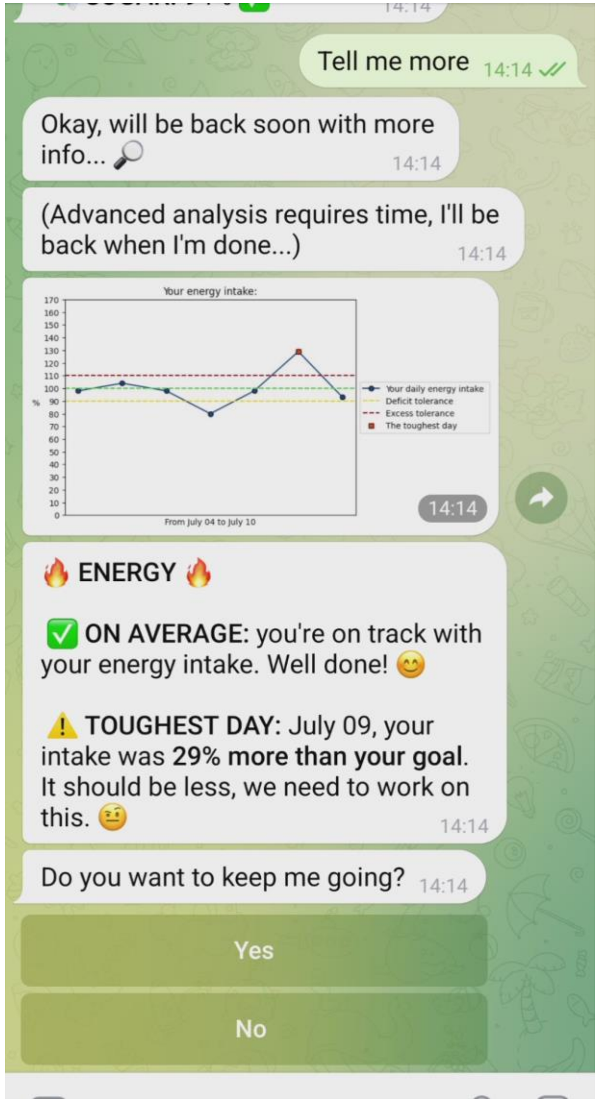

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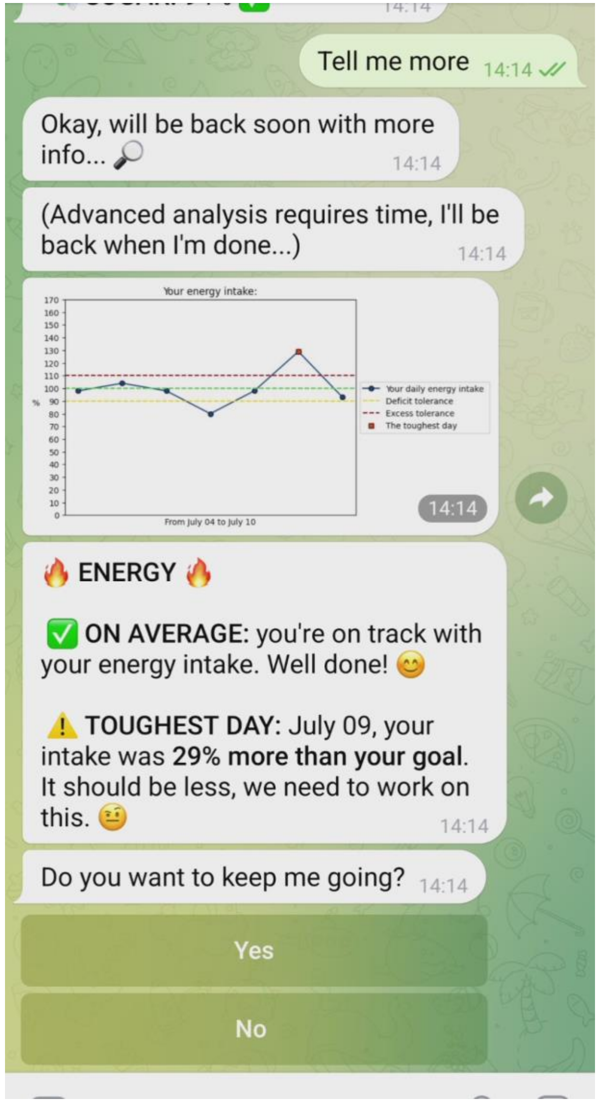

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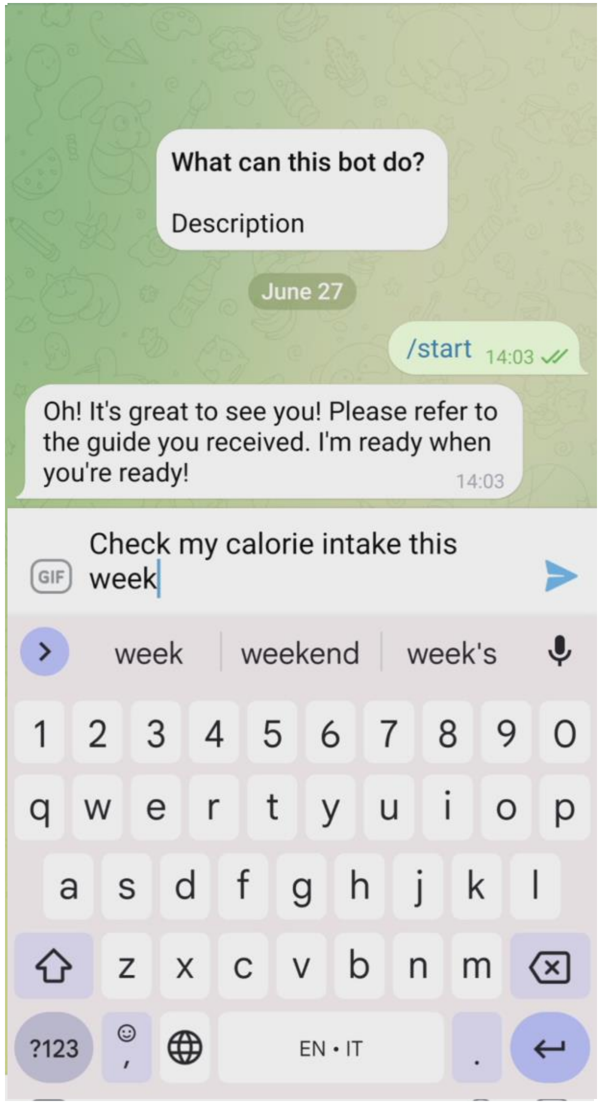

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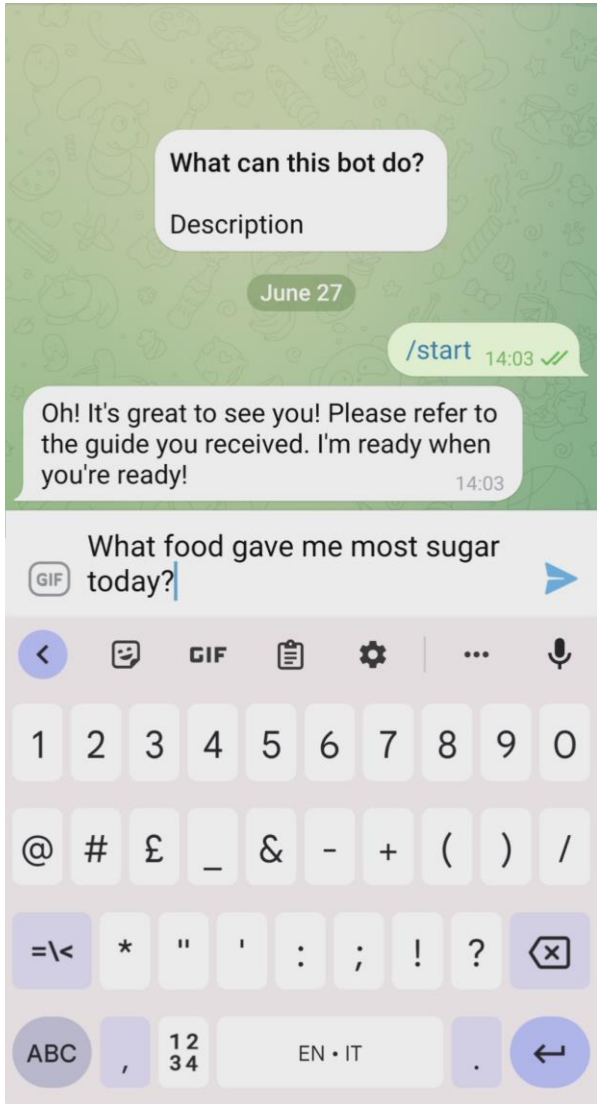

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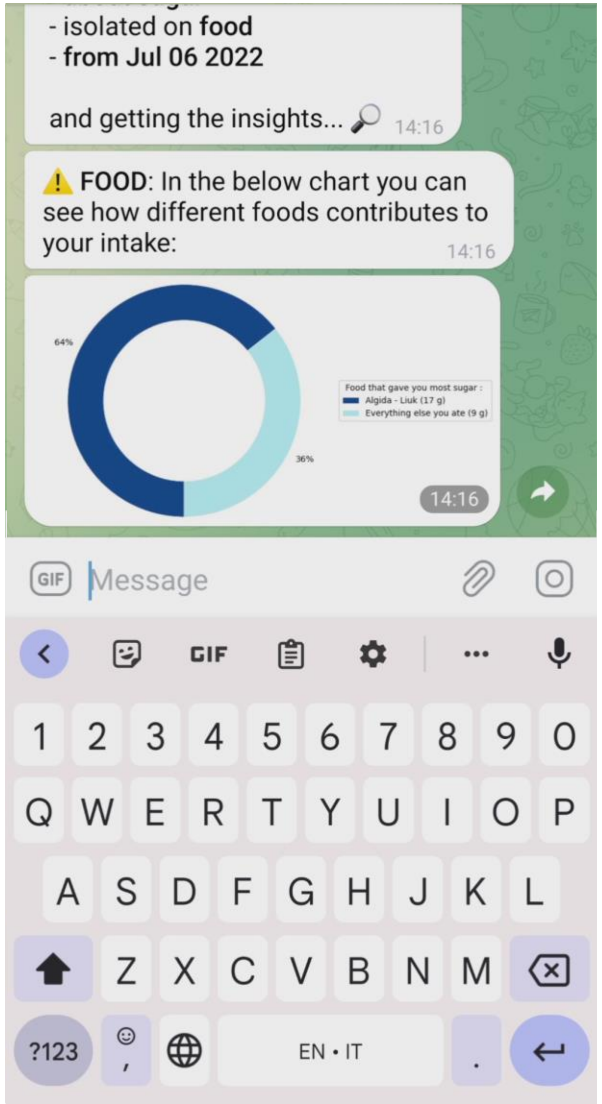

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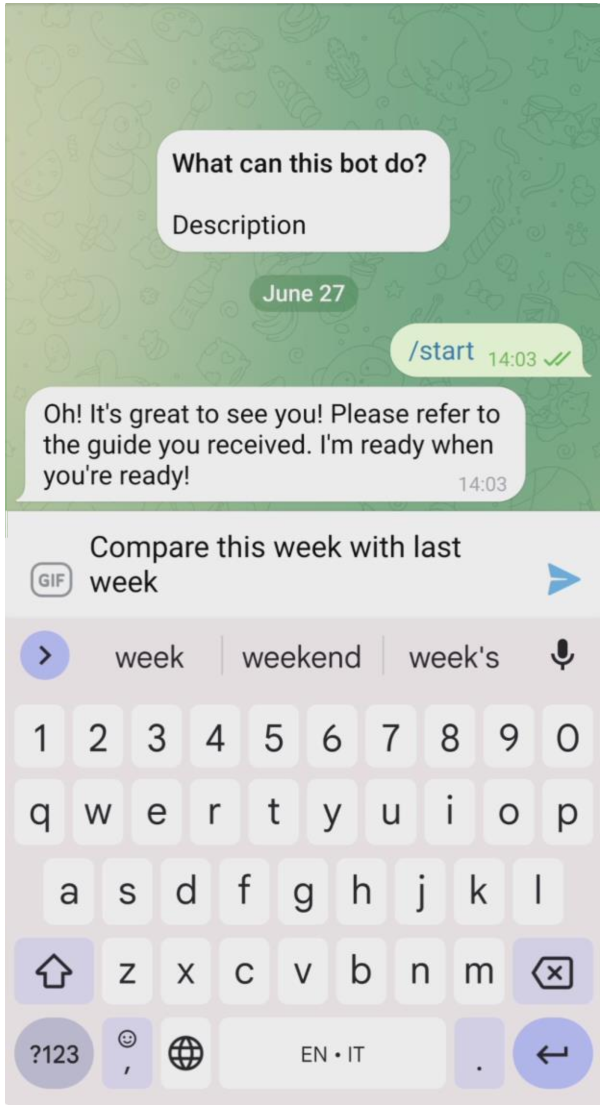

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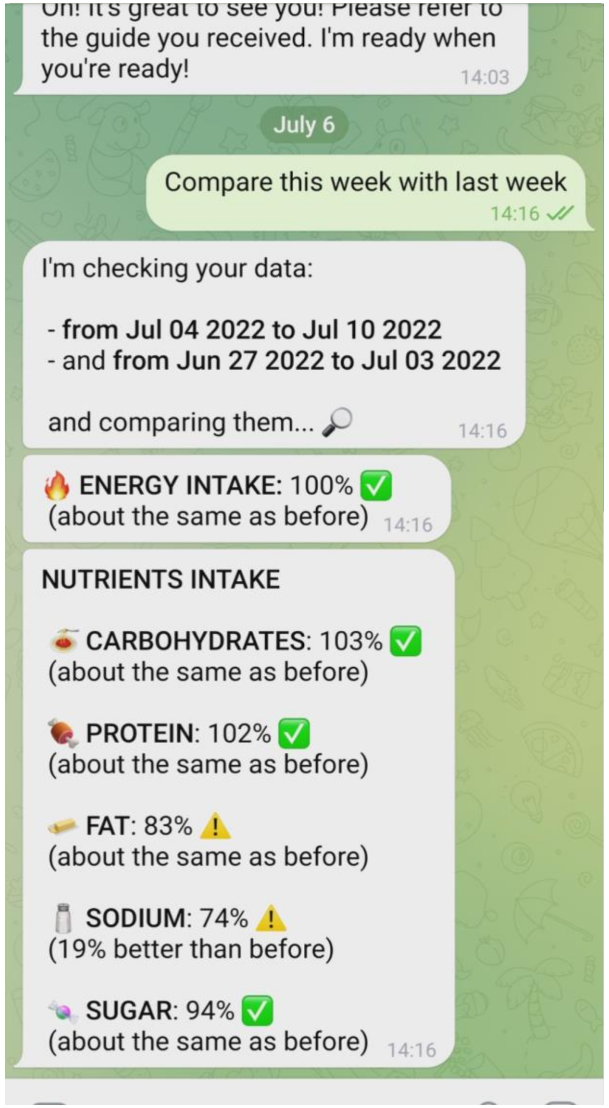

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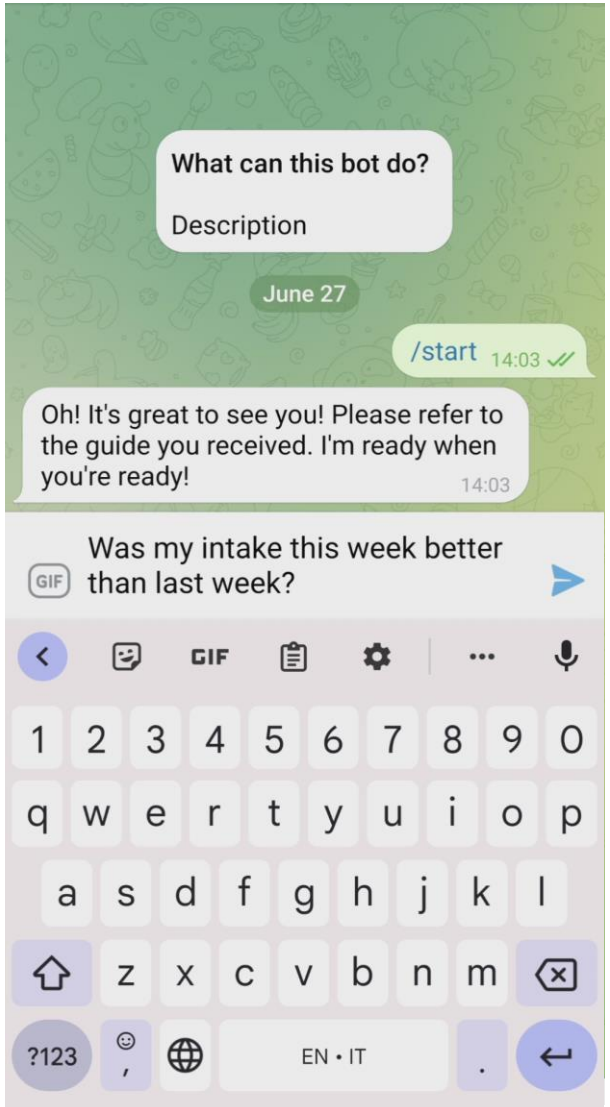

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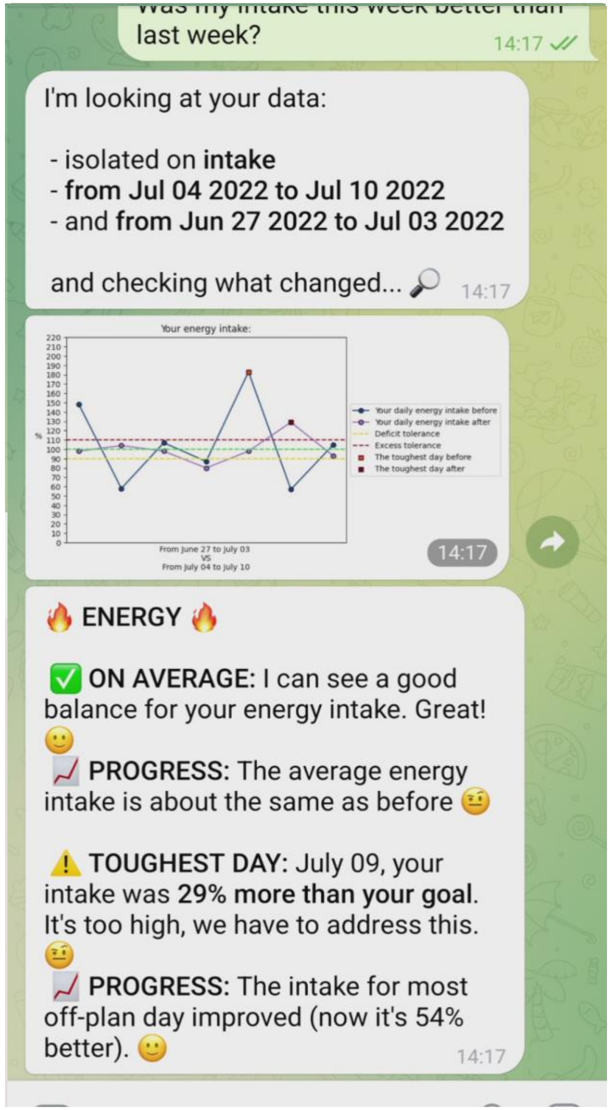

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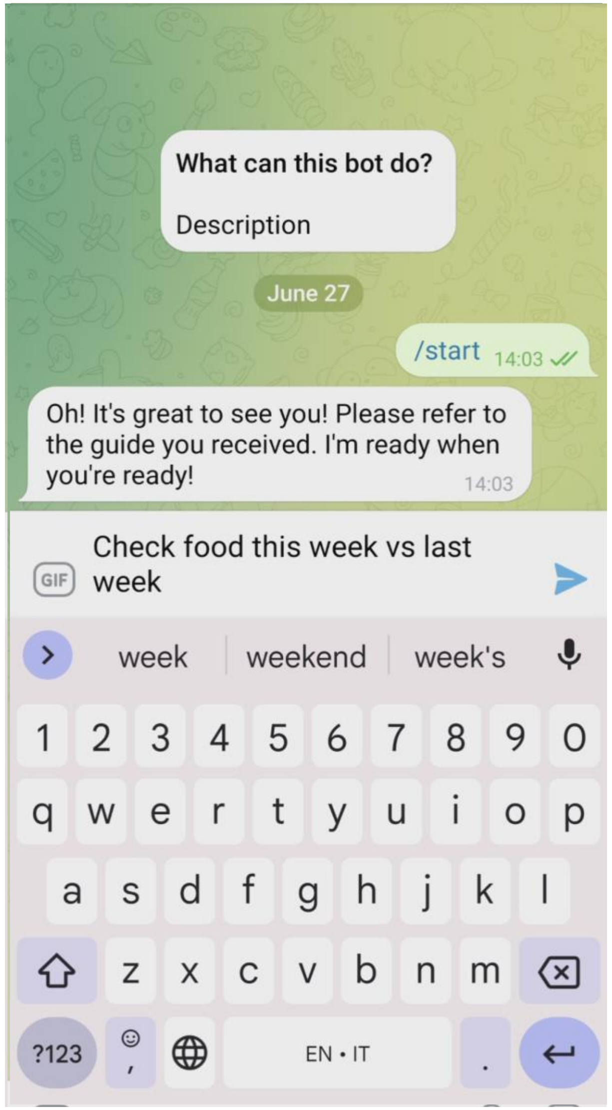

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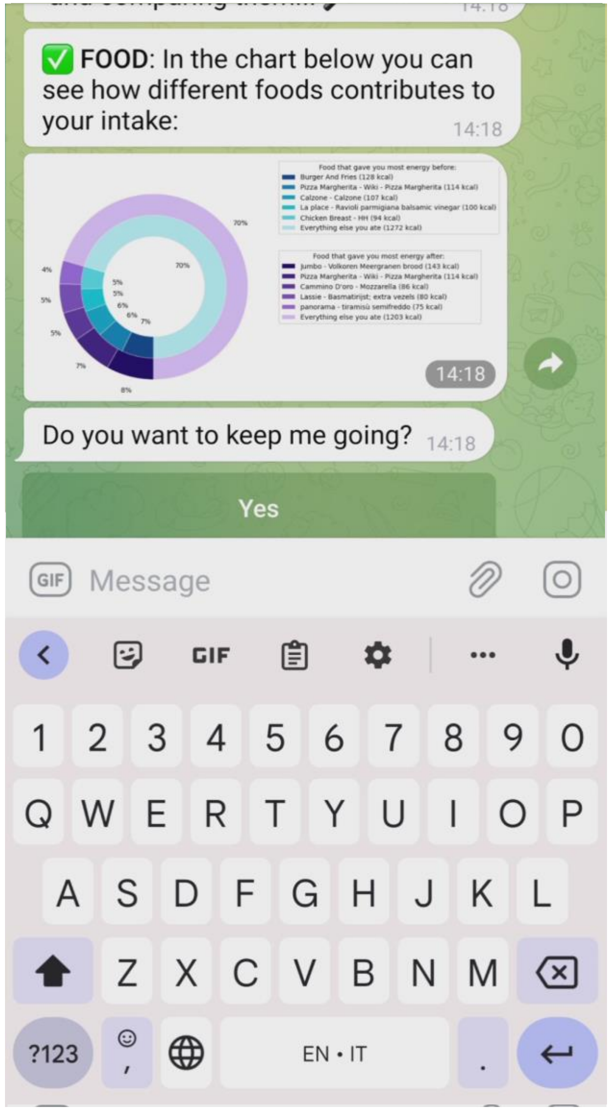

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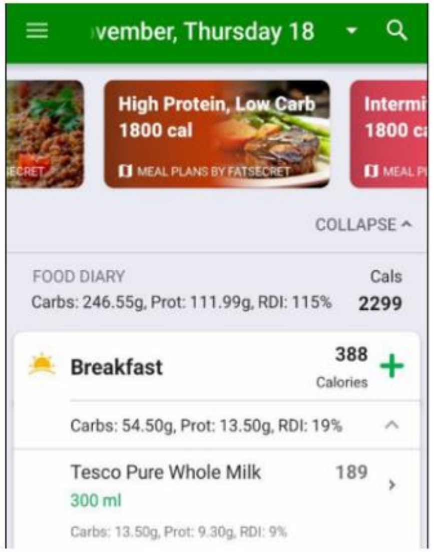

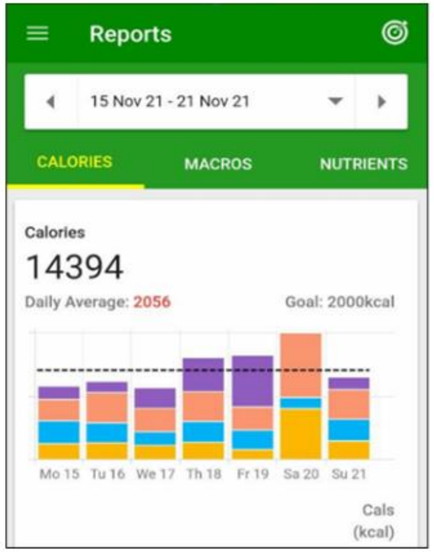

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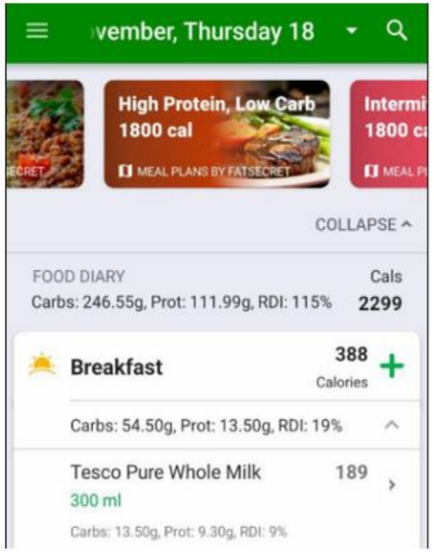

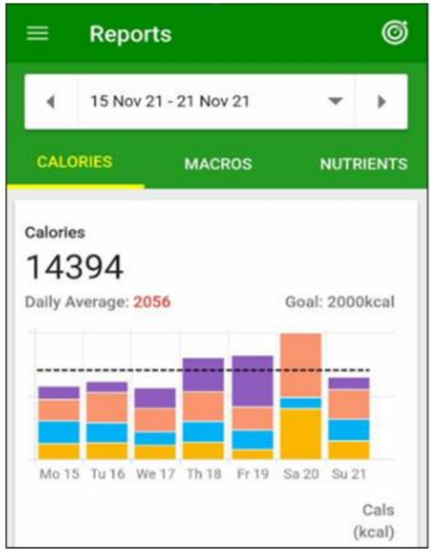

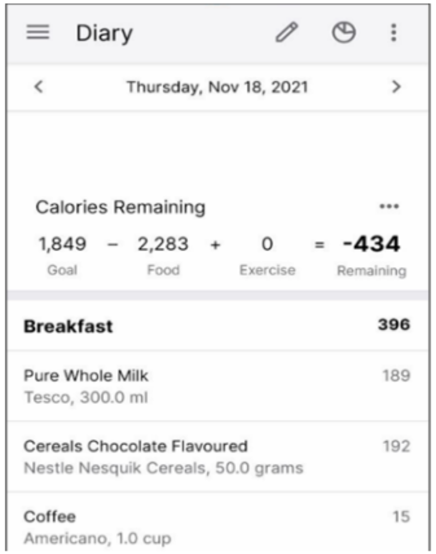

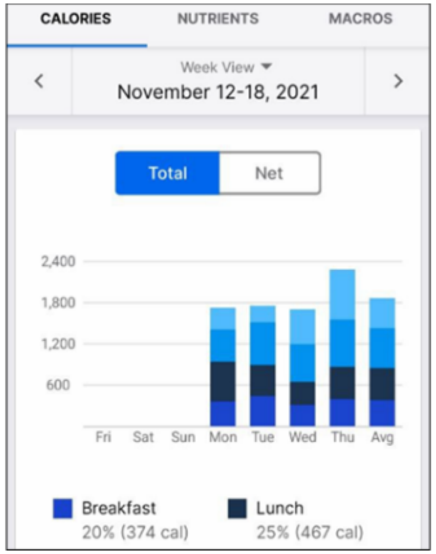

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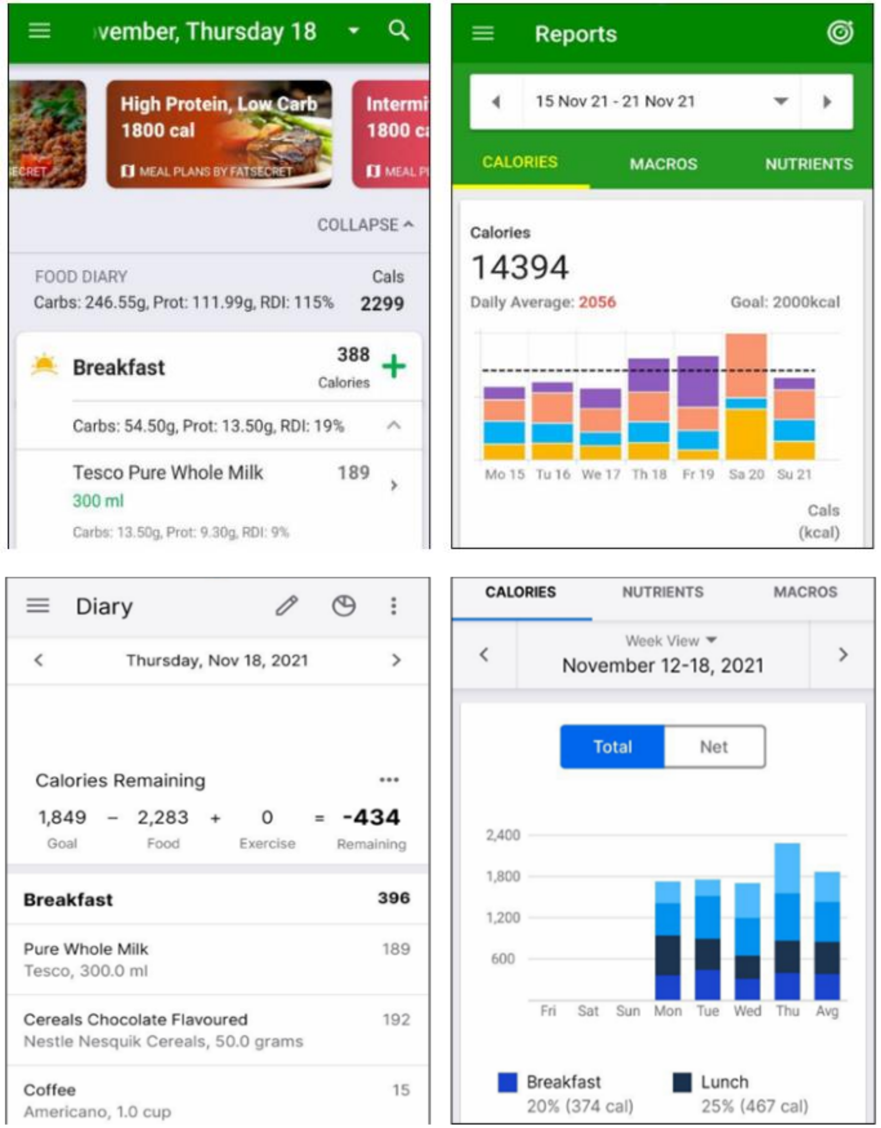

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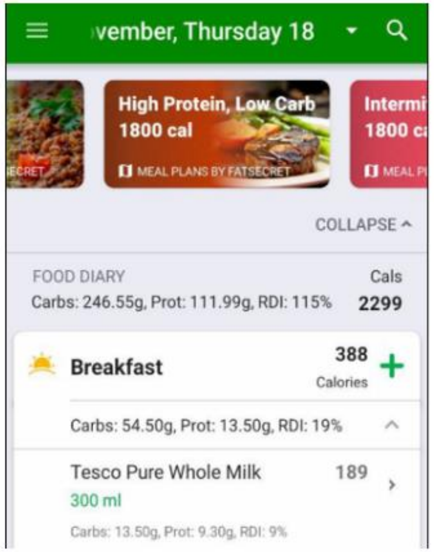

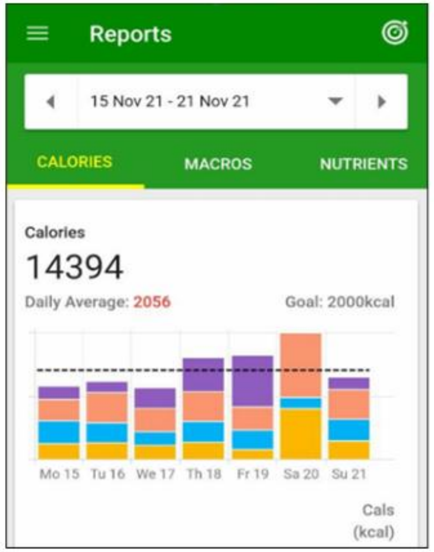

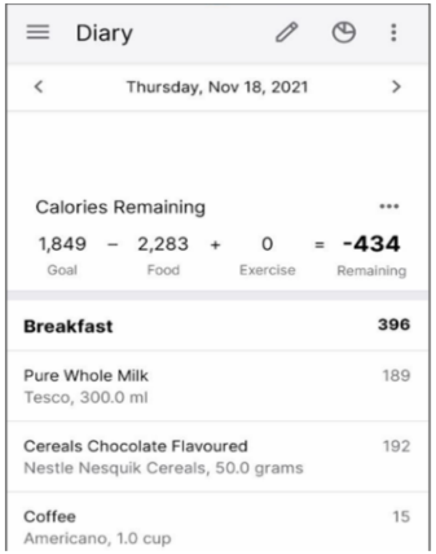

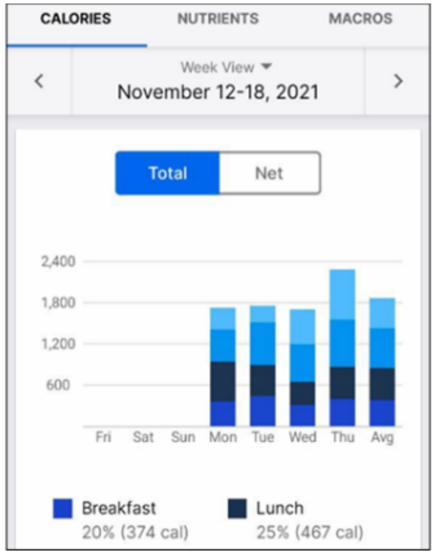

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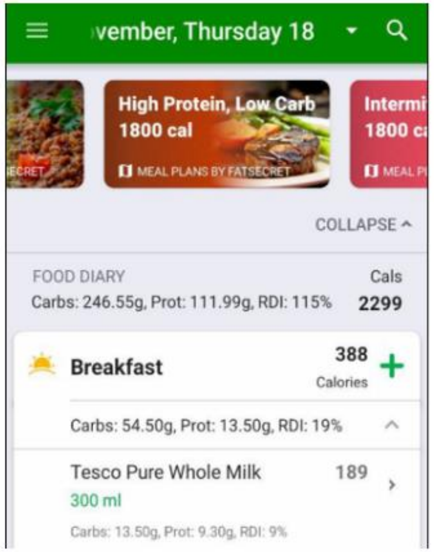

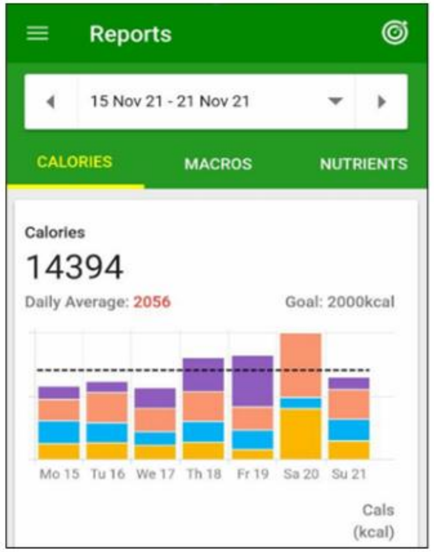

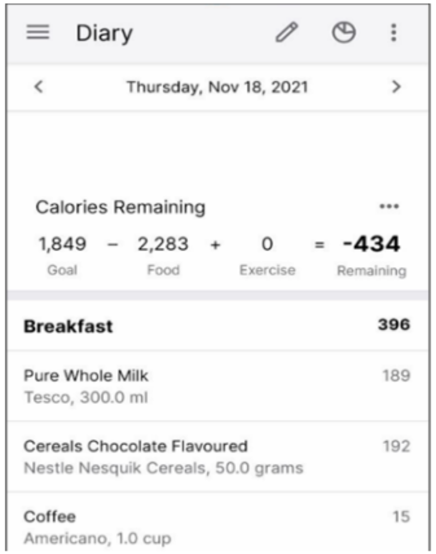

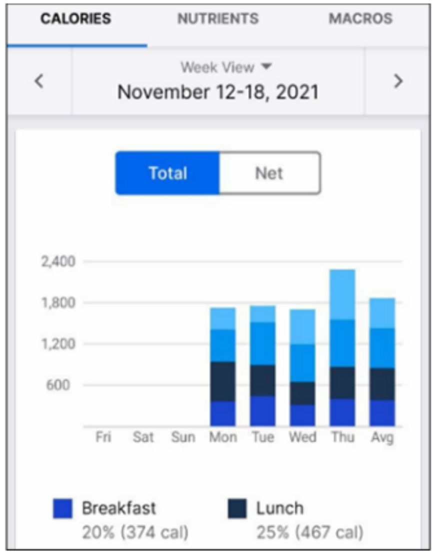

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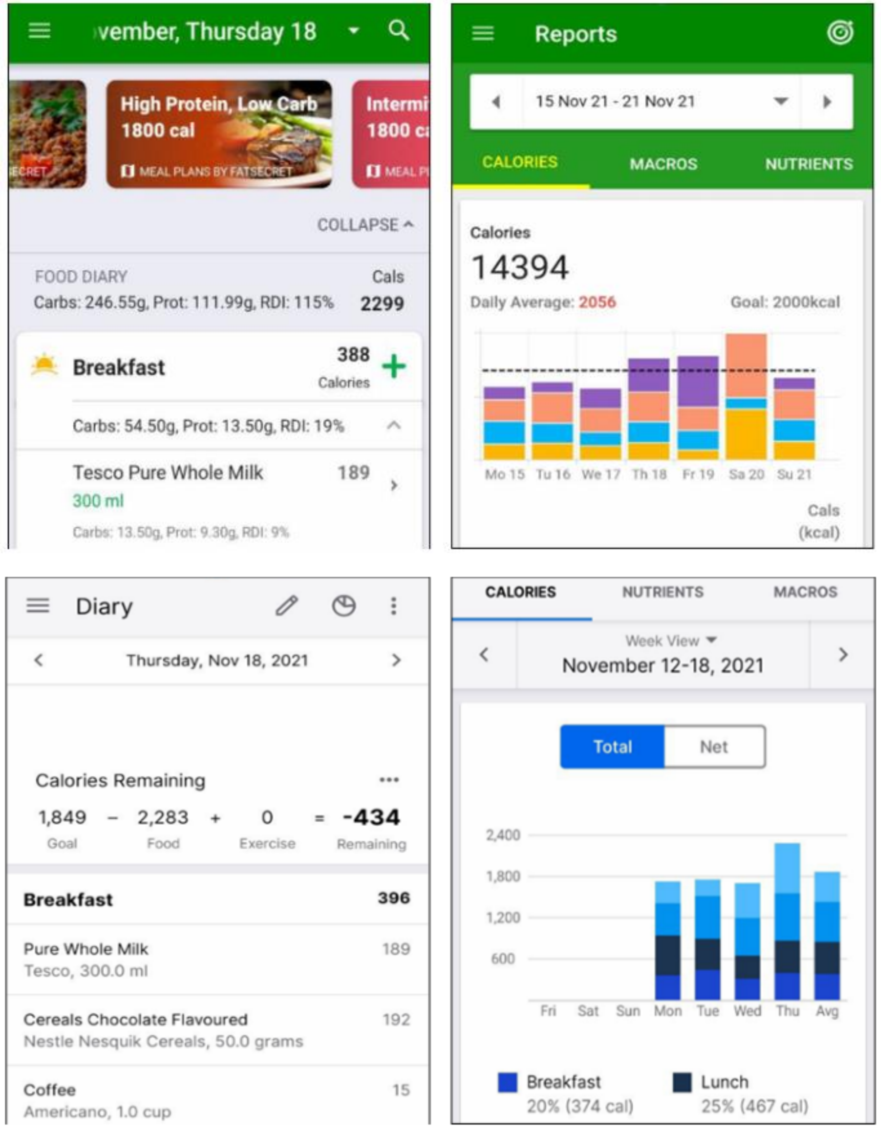

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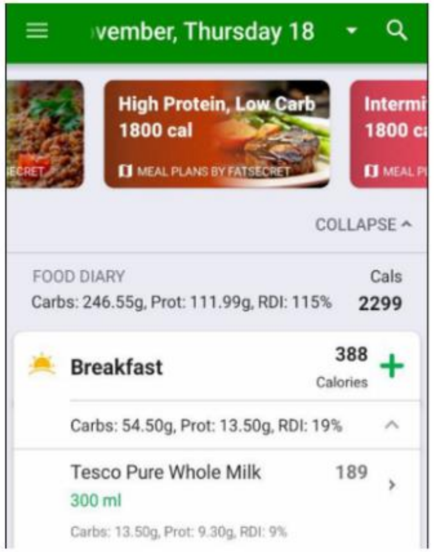

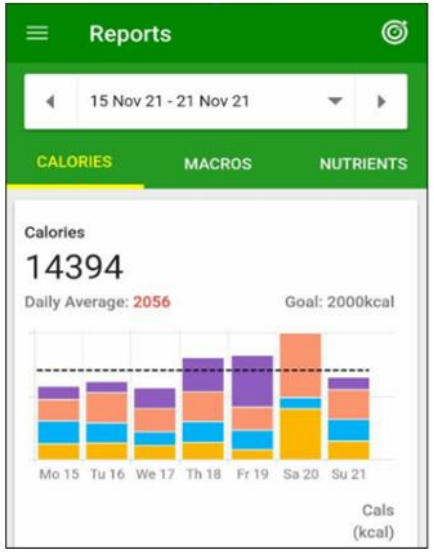

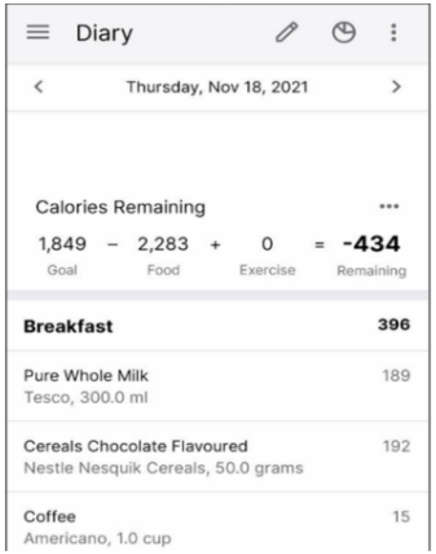

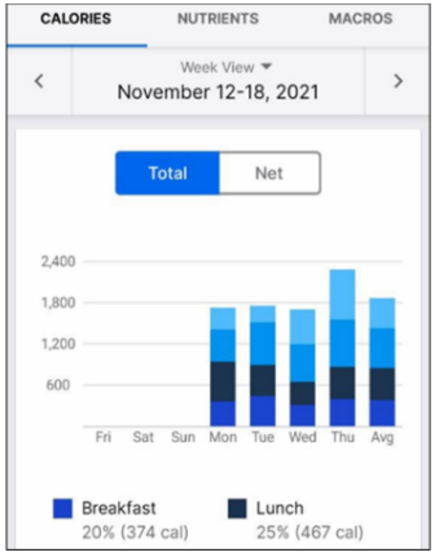

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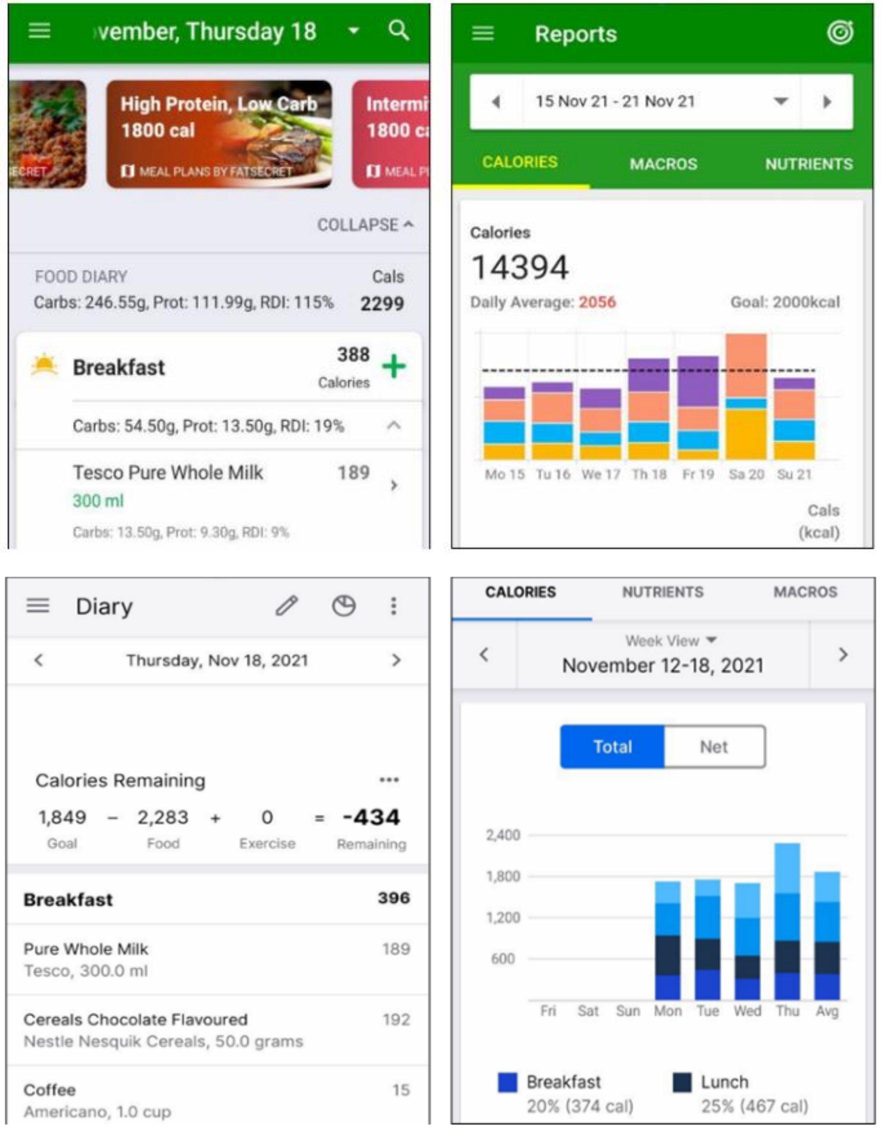

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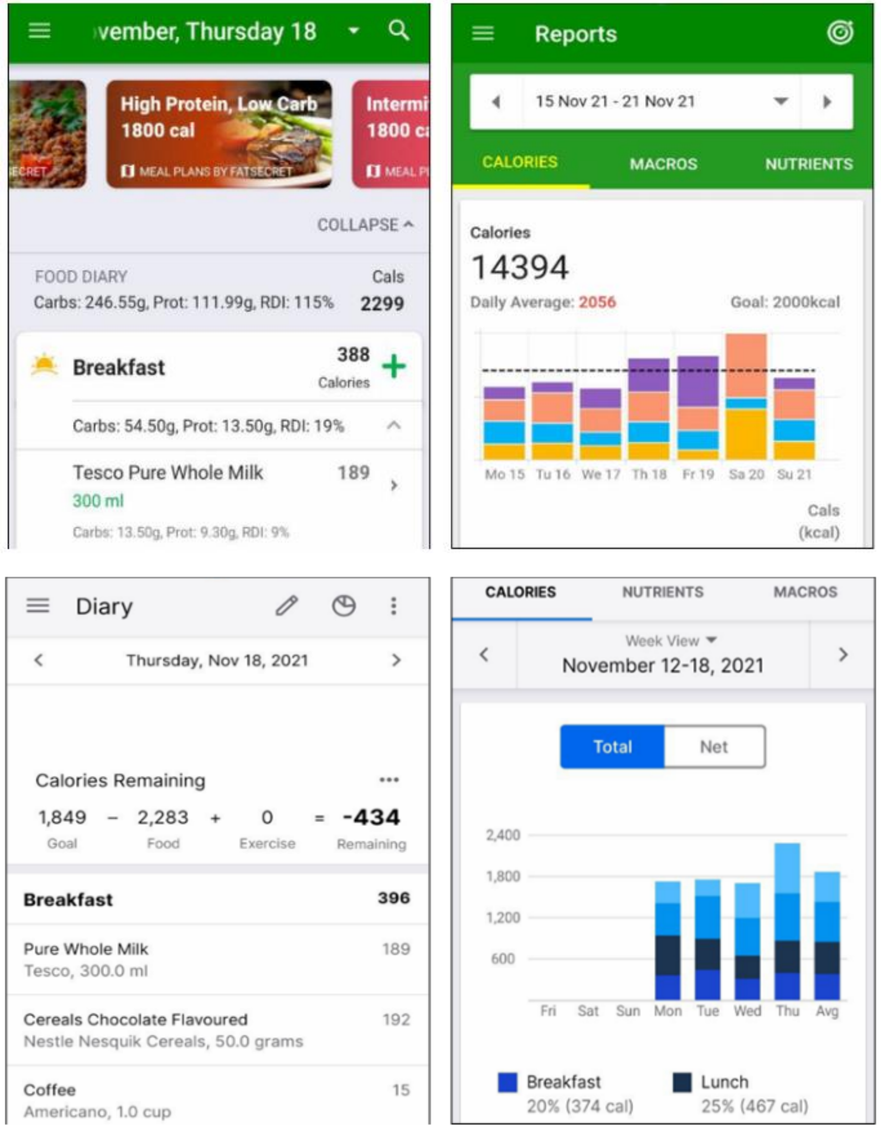

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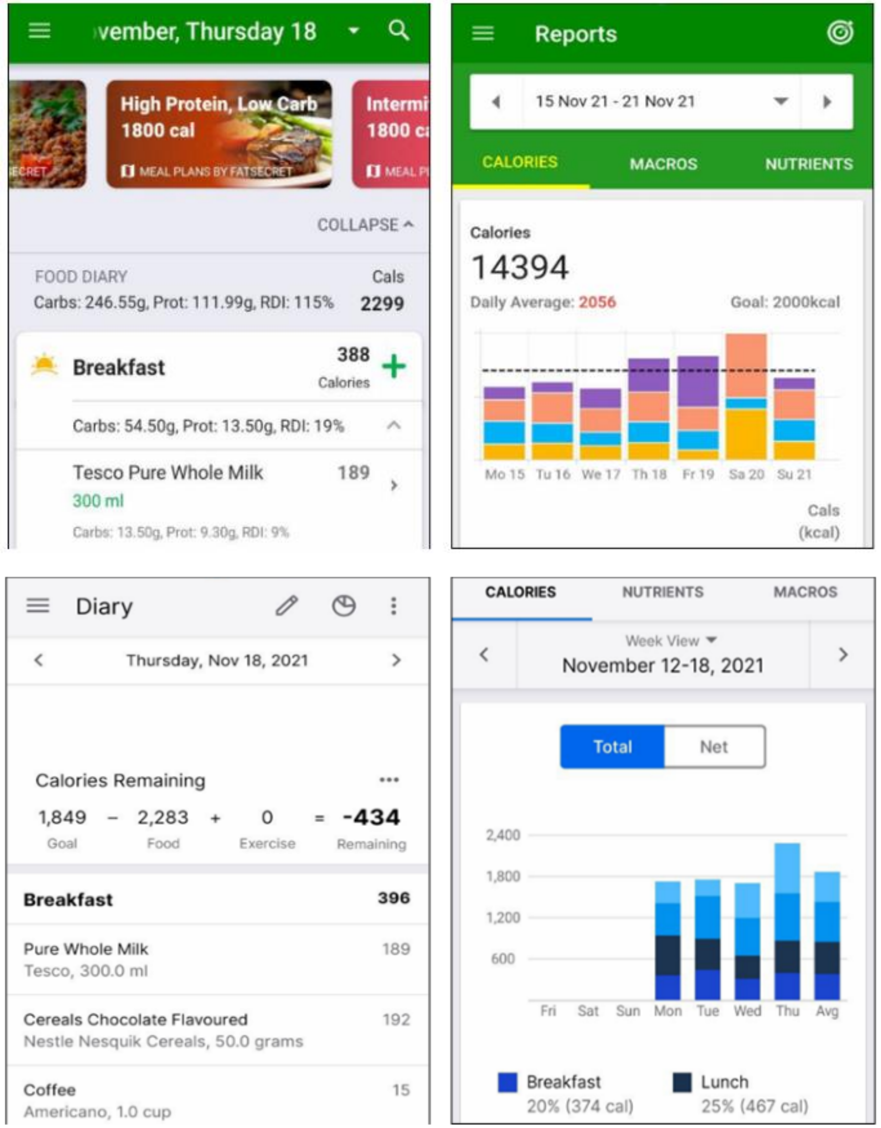
  - Inter-sample **nutrition literacy**
  - Workers' **perception of the tool**



Measuring informativeness

Measuring informativeness

- “How successfully a person is able to convey an intended message” (Webster and Morris, 2019):

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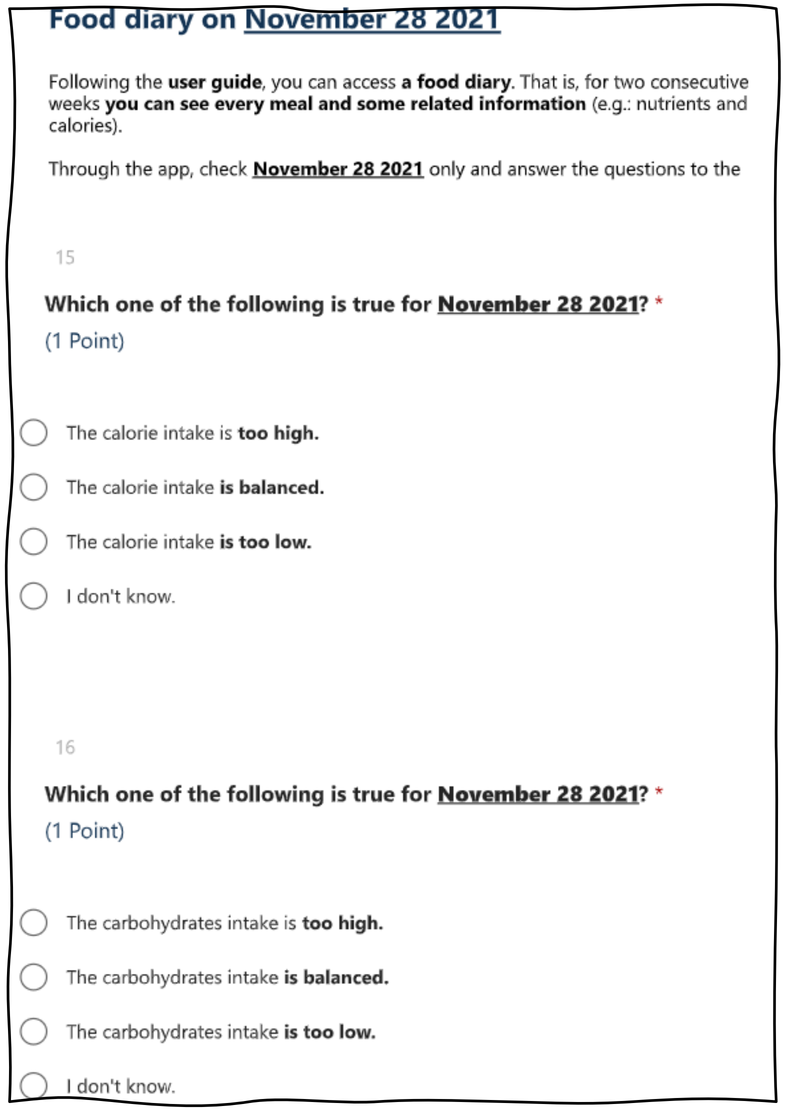

Food diary on November 28 2021

Following the **user guide**, you can access **a food diary**. That is, for two consecutive weeks **you can see every meal and some related information** (e.g.: nutrients and calories).

Through the app, check **November 28 2021** only and answer the questions to the

15

Which one of the following is true for November 28 2021? *

(1 Point)

- The calorie intake is **too high.**
- The calorie intake **is balanced.**
- The calorie intake **is too low.**
- I don't know.

16

Which one of the following is true for November 28 2021? *

(1 Point)

- The carbohydrates intake is **too high.**
- The carbohydrates intake **is balanced.**
- The carbohydrates intake **is too low.**
- I don't know.

Measuring informativeness

- “How successfully a ~~person~~ tool is able to convey an intended message” (**Webster and Morris, 2019**):

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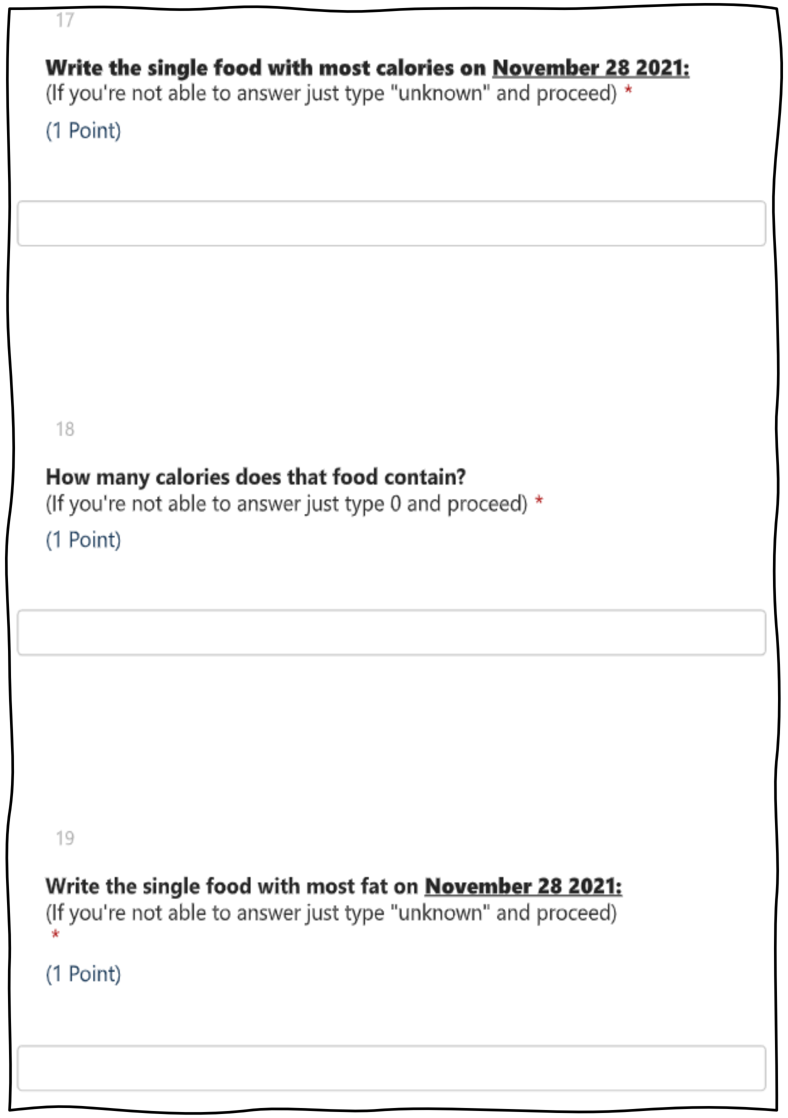

17

Write the single food with most calories on <u>November 28 2021:</u>
(If you're not able to answer just type "unknown" and proceed) *

(1 Point)

18

How many calories does that food contain?
(If you're not able to answer just type 0 and proceed) *

(1 Point)

19

Write the single food with most fat on <u>November 28 2021:</u>
(If you're not able to answer just type "unknown" and proceed)
*

(1 Point)

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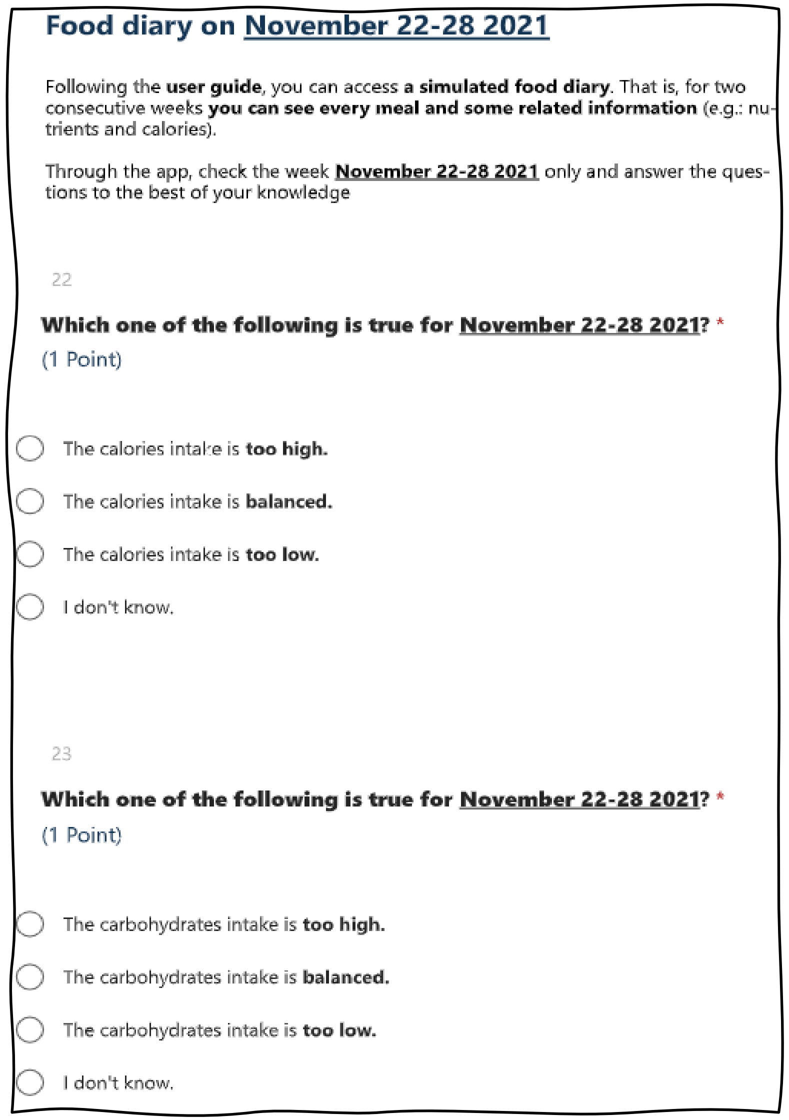

Food diary on November 22-28 2021

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Through the app, check the week **November 22-28 2021** only and answer the questions to the best of your knowledge

22

Which one of the following is true for November 22-28 2021? *

(1 Point)

- The calories intake is **too high.**
- The calories intake is **balanced.**
- The calories intake is **too low.**
- I don't know.

23

Which one of the following is true for November 22-28 2021? *

(1 Point)

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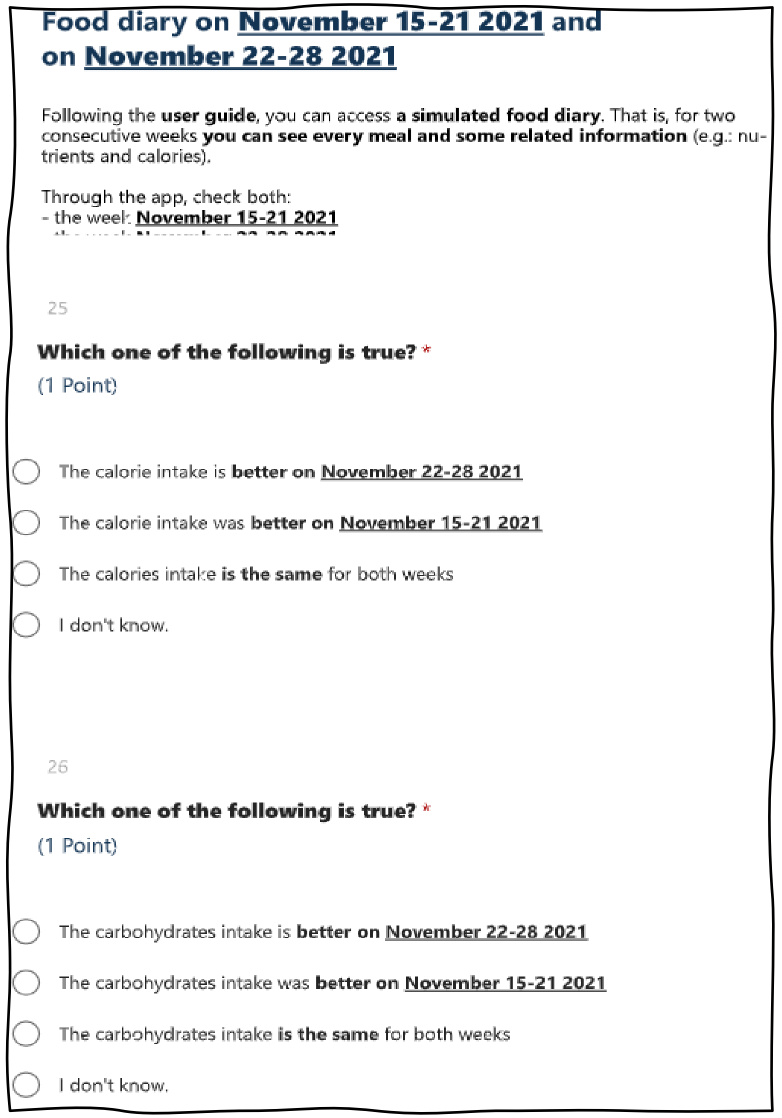

Food diary on November 15-21 2021 and on November 22-28 2021

Following the **user guide**, you can access **a simulated food diary**. That is, for two consecutive weeks **you can see every meal and some related information** (e.g.: nutrients and calories).

Through the app, check both:
- the week: November 15-21 2021

25

Which one of the following is true? *

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- The calorie intake is **better on** November 22-28 2021
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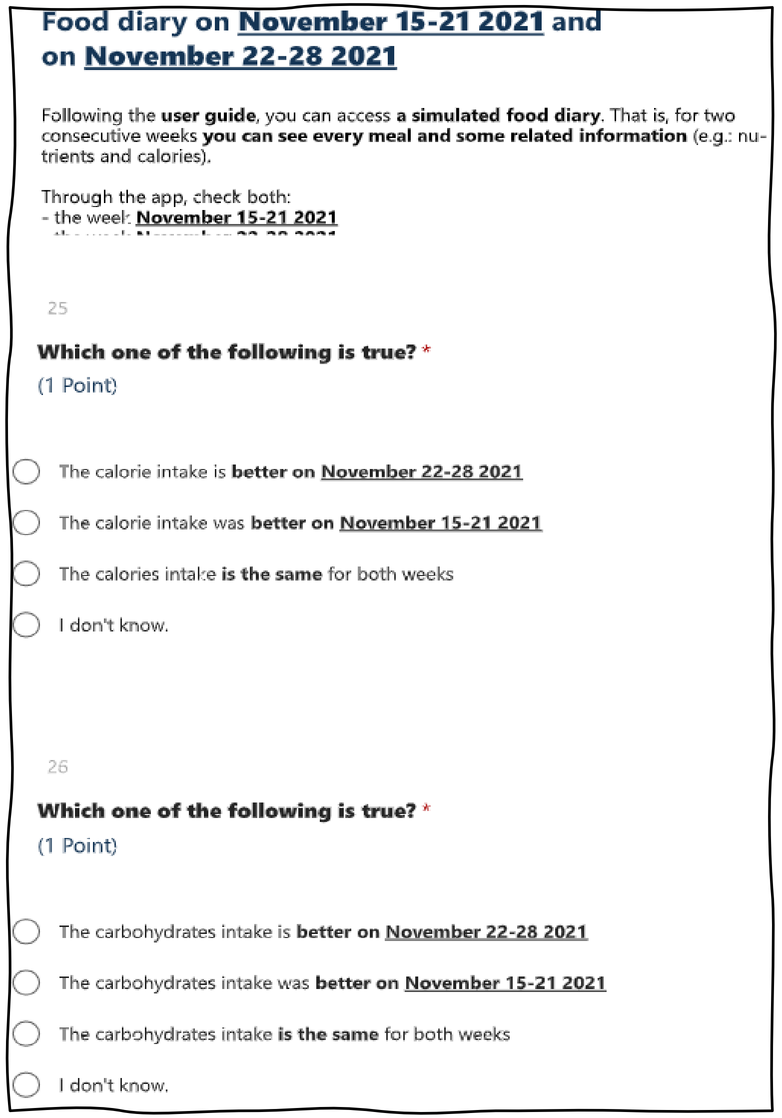

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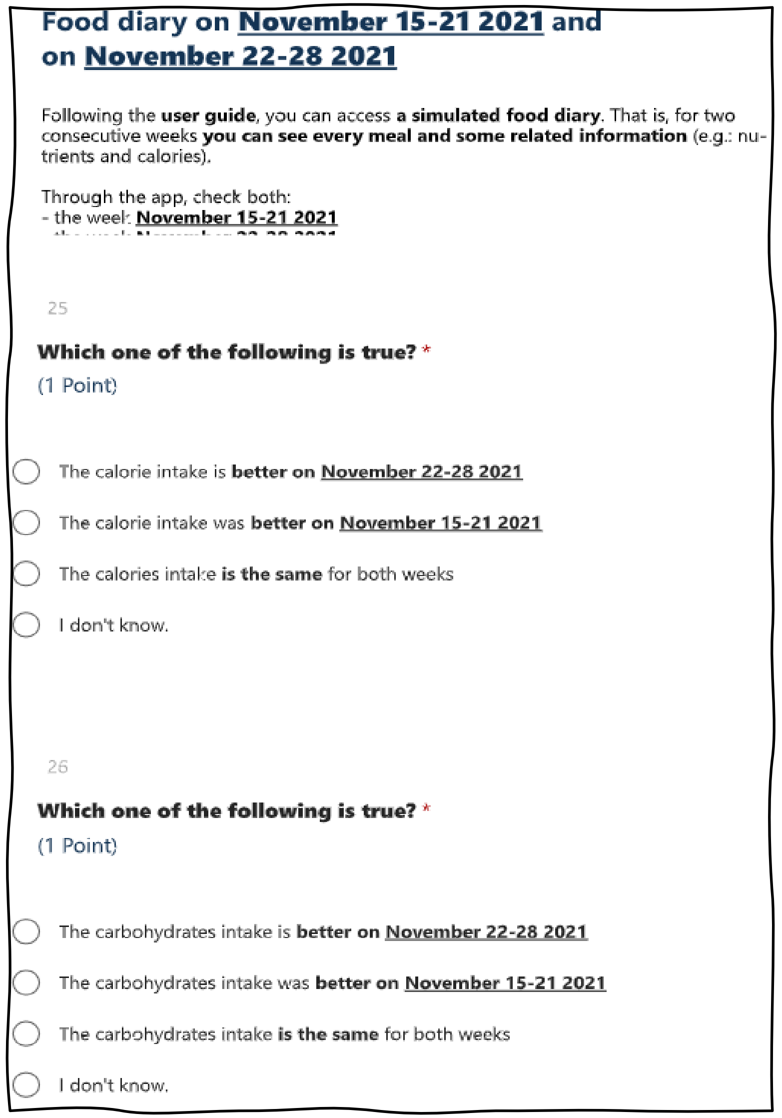

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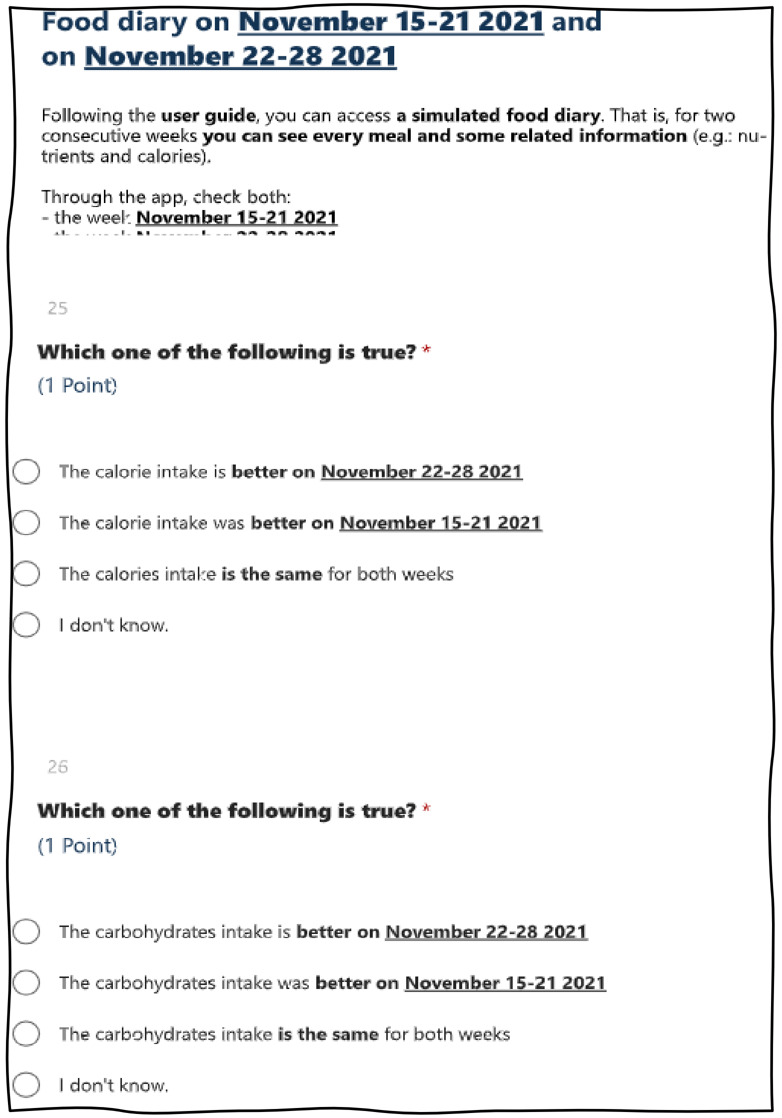

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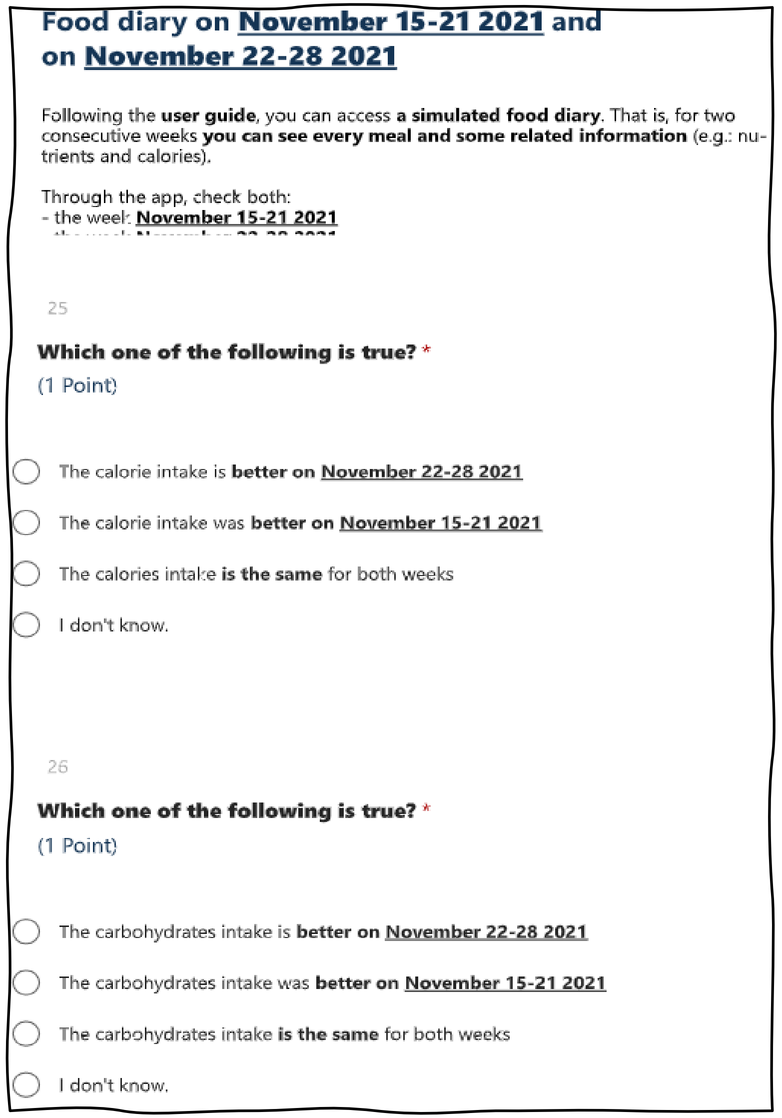

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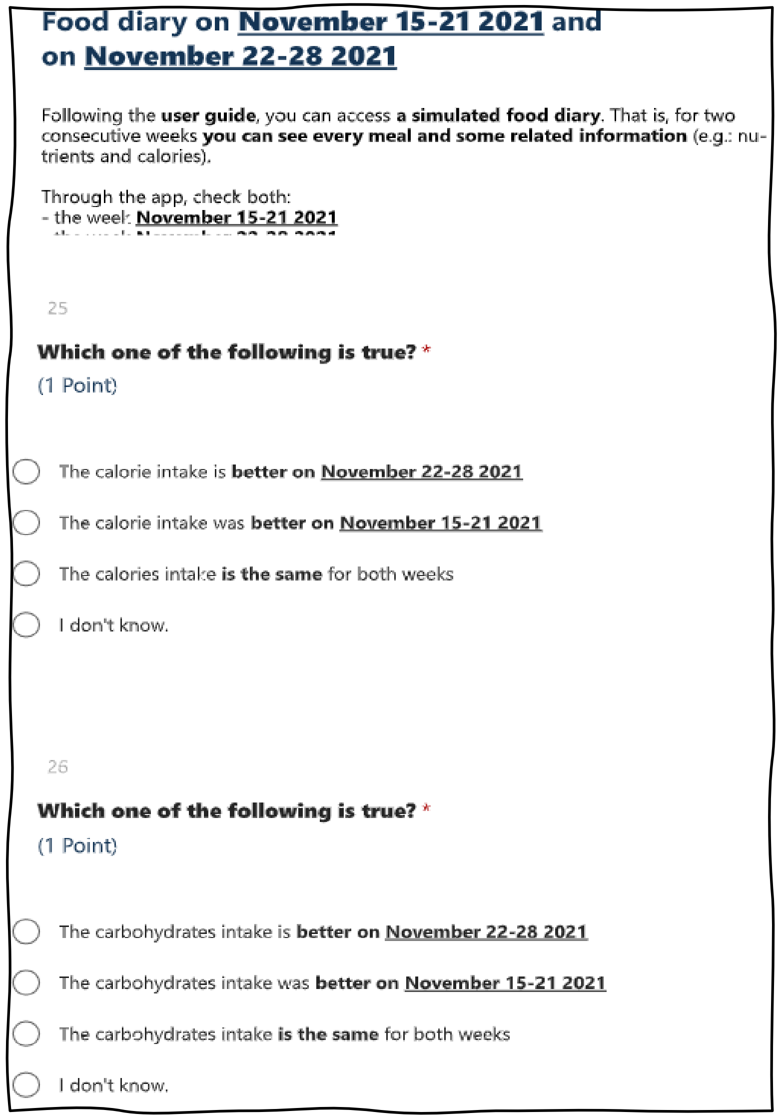
- H1: Chatbot workers **scored higher** on the quiz than MFP or FS workers.



Measuring nutrition literacy & feedback

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- We adopt the **Newest Vital Sign** (NVS) (Weiss et al., 2005; Powers et al., 2010)

Measuring nutrition literacy & feedback

- We adopt the **Newest Vital Sign** (NVS) (**Weiss et al., 2005; Powers et al., 2010**)
  - **6 questions** about nutritional information, extracted from an ice cream label

Nutrition Facts

Serving Size	½ cup
Servings per container	4
Amount per serving	
Calories 250	Fat Cal 120
	%DV
Total Fat 13g	20%
Sat Fat 9g	40%
Cholesterol 28mg	12%
Sodium 55mg	2%
Total Carbohydrate 30g	12%
Dietary Fiber 2g	
Sugars 23g	
Protein 4g	8%

*Percentage Daily Values (DV) are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

Ingredients: Cream, Skim Milk, Liquid Sugar, Water, Egg Yolks, Brown Sugar, Milkfat, Peanut Oil, Sugar, Butter, Salt, Carrageenan, Vanilla Extract.

Price: $12.72

Measuring nutrition literacy & feedback

- We adopt the **Newest Vital Sign** (NVS) (**Weiss et al., 2005; Powers et al., 2010**)
  - **6 questions** about nutritional information, extracted from an ice cream label

- H2: There was a positive correlation between **NVS score** and **quiz score** in our experiment, but not for chatbot workers.

Measuring nutrition literacy & feedback

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  - **6 questions** about nutritional information, extracted from an ice cream label

- H2: There was a positive correlation between **NVS score** and **quiz score** in our experiment, but not for chatbot workers.

- Finally, we ask every worker to evaluate **their assigned tool**

Please give a score to each statement, based on how much you agree with each one: *

	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree
$tool_name helped me finding problems in the food diary.	○	○	○	○	○
$tool_name helped me answer the questions.	○	○	○	○	○
Getting the answers with **$tool_name** was quick.	○	○	○	○	○
$tool_name was easy to use and understand.	○	○	○	○	○
I think I could improve my diet using **$tool_name**.	○	○	○	○	○

Measuring nutrition literacy & feedback

- We adopt the **Newest Vital Sign** (NVS) (**Weiss et al., 2005; Powers et al., 2010**)
  - **6 questions** about nutritional information, extracted from an ice cream label

- H2: There was a positive correlation between **NVS score** and **quiz score** in our experiment, but not for chatbot workers.

- Finally, we ask every worker to evaluate **their assigned tool**
  - Additionally, we ask them about their **past experience** with dieting tools.

Please give a score to each statement, based on how much you agree with each one: *

	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree
$tool_name helped me finding problems in the food diary.	○	○	○	○	○
$tool_name helped me answer the questions.	○	○	○	○	○
Getting the answers with **$tool_name** was quick.	○	○	○	○	○
$tool_name was easy to use and understand.	○	○	○	○	○
I think I could improve my diet using **$tool_name**.	○	○	○	○	○

Measuring nutrition literacy & feedback

- We adopt the **Newest Vital Sign** (NVS) (**Weiss et al., 2005; Powers et al., 2010**)
  - **6 questions** about nutritional information, extracted from an ice cream label
- H2: There was a positive correlation between **NVS score** and **quiz score** in our experiment, but not for chatbot workers.
- Finally, we ask every worker to evaluate **their assigned tool**
  - Additionally, we ask them about their **past experience** with dieting tools.
- H3: Our chatbot received **better ratings** than MFP and FS

Please give a score to each statement, based on how much you agree with each one: *

	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree
$tool_name helped me finding problems in the food diary.	○	○	○	○	○
$tool_name helped me answer the questions.	○	○	○	○	○
Getting the answers with **$tool_name** was quick.	○	○	○	○	○
$tool_name was easy to use and understand.	○	○	○	○	○
I think I could improve my diet using **$tool_name**.	○	○	○	○	○

Preliminary checks

Preliminary checks

- Nutrition literacy uniformity

	Workers per class		
NVS class	CB	FS	MFP
LOW (0-1pt)	1	0	9
MID (2-3pt)	5	3	5
HIGH (4-6pt)	21	26	17

Table 2: Distribution of nutrition literacy for our population.

CB = Chatbot; FS = FatSecret; MFP = MyFitnessPal

Preliminary checks

- Nutrition literacy uniformity
  - Problem: most workers with **low NVS scores** are in MFP sample

	Workers per class		
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Preliminary checks

- Nutrition literacy uniformity
  - Problem: most workers with low NVS scores are in MFP sample
  - Solution: removing every worker with low NVS score.
    - Pro: keeps the comparison fair

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    - Cons: potentially invalidates H2

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  - Solution: **removing** every worker with low NVS score.
    - Pro: keeps the comparison fair
    - Cons: potentially invalidates H2
- Comparison of past experience with diet apps

	Workers per class		
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    - Cons: potentially invalidates H2

- Comparison of past experience with diet apps
  - No significant difference either:

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    - Globally **(p=0.47)**

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    - Pro: keeps the comparison fair
    - Cons: potentially invalidates H2

- Comparison of past experience with diet apps
  - No significant difference either:
    - Globally **(p=0.47)**
    - For workers who used diet tools in the past only **(p=0.27)**

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Table 2: Distribution of nutrition literacy for our population.

CB = Chatbot; FS = FatSecret; MFP = MyFitnessPal

Quiz scores

	Average score		
Topic	CB	FS	MFP
Overall (10pt)	**6.65**	4.13	5.22
Day analysis (2pt)	1.15	0.76	**1.32**
Food analysis (4pt)	**2.85**	2.14	0.91
Week analysis (2pt)	**1.35**	0.66	1.05
Weeks comparison (2pt)	**1.31**	0.59	1.14

	Score differences		
Topic	CB-FS	CB-MFP	MFP-FS
Overall (10pt)	+2.52**	+1.43	+1.09
Day analysis (2pt)	+0.40	-0.16	+0.56
Food analysis (4pt)	+0.71	+1.94***	-1.23*
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CB = Chatbot; FS = FatSecret; MFP = MyFitnessPal

Quiz scores

- Overall, CB beat both apps

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CB = Chatbot; FS = FatSecret; MFP = MyFitnessPal

Quiz scores

- Overall, **CB** beat both apps
  - Significantly better than **FS**

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CB = Chatbot; FS = FatSecret; MFP = MyFitnessPal

Quiz scores

- Overall, CB beat both apps
  - Significantly better than FS
  - Regardless of the tool, scores are low

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- Overall, **CB** beat both apps
  - Significantly better than **FS**
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- Per-task: **CB** beat both apps **in most cases**

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- Per-task: **CB** beat both apps **in most cases**
  - Significantly better than **MFP** in:
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  - Significantly better than **MFP** in:
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- Overall, **CB** beat both apps
  - Significantly better than **FS**
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- Per-task: **CB** beat both apps **in most cases**
  - Significantly better than **MFP** in:
    - Food analysis
  - Significantly better than **FS** in:
    - Week analysis
    - Weeks comparison
  - CB was beaten only by **MFP** in day analysis

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    - Food analysis
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- Is there a link between the used tool and scores in specific tasks?

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CB = Chatbot; FS = FatSecret; MFP = MyFitnessPal

Quiz scores

- Overall, CB beat both apps
  - Significantly better than FS
  - Regardless of the tool, scores are low

- Per-task: CB beat both apps in most cases
  - Significantly better than MFP in:
    - Food analysis
  - Significantly better than FS in:
    - Week analysis
    - Weeks comparison
  - CB was beaten only by MFP in day analysis

- Is there a link between the used tool and scores in specific tasks?
  - We inspect score distribution by tool and tasks

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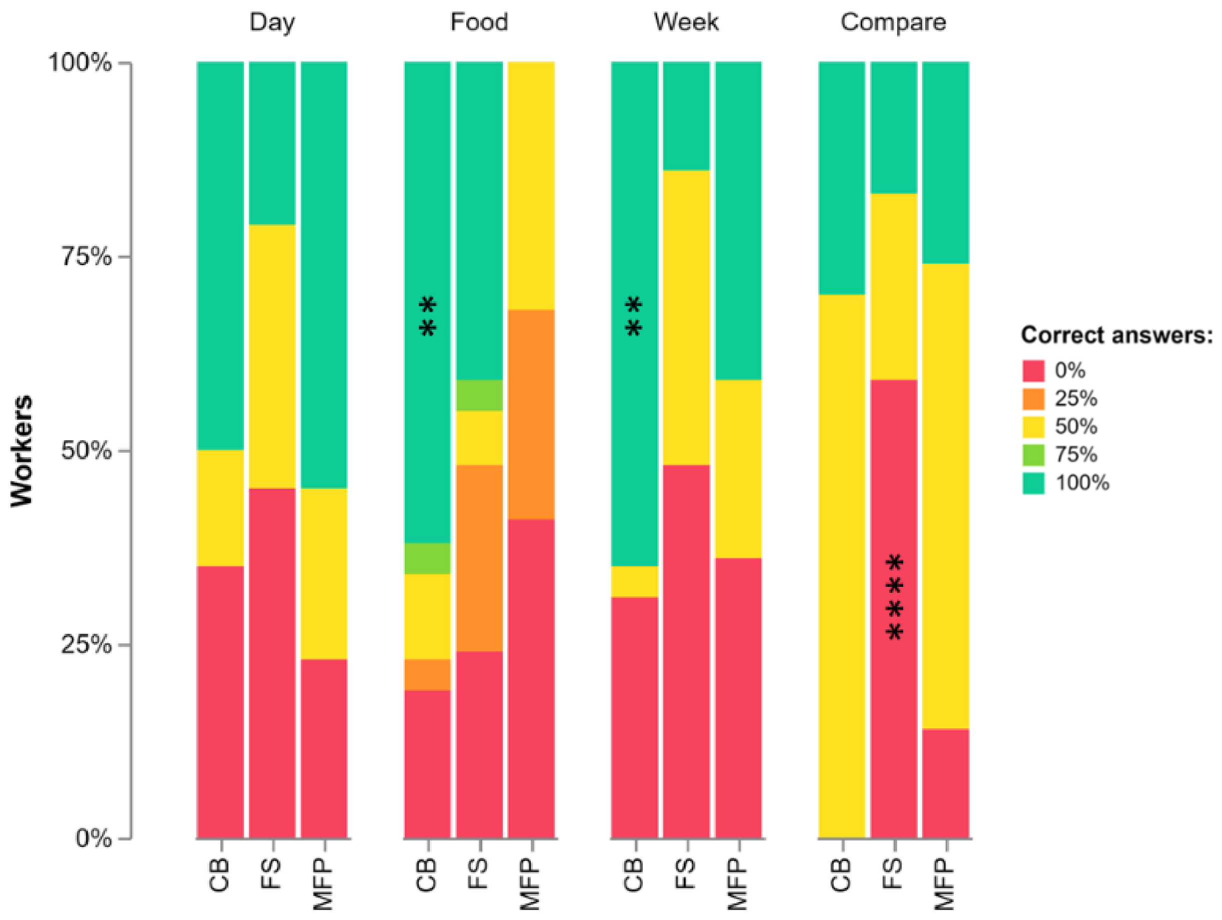
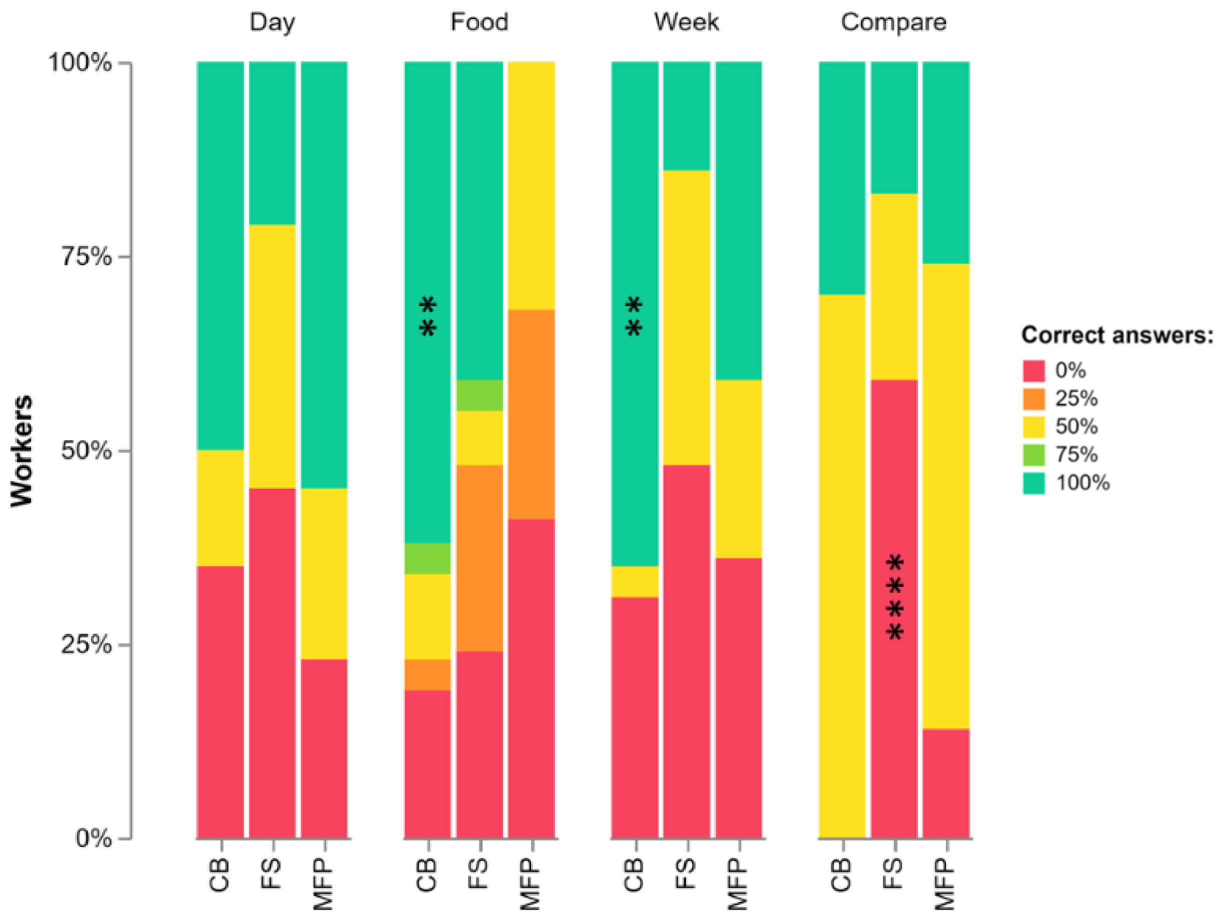


CB = Chatbot; FS = FatSecret; MFP = MyFitnessPal

Quiz scores

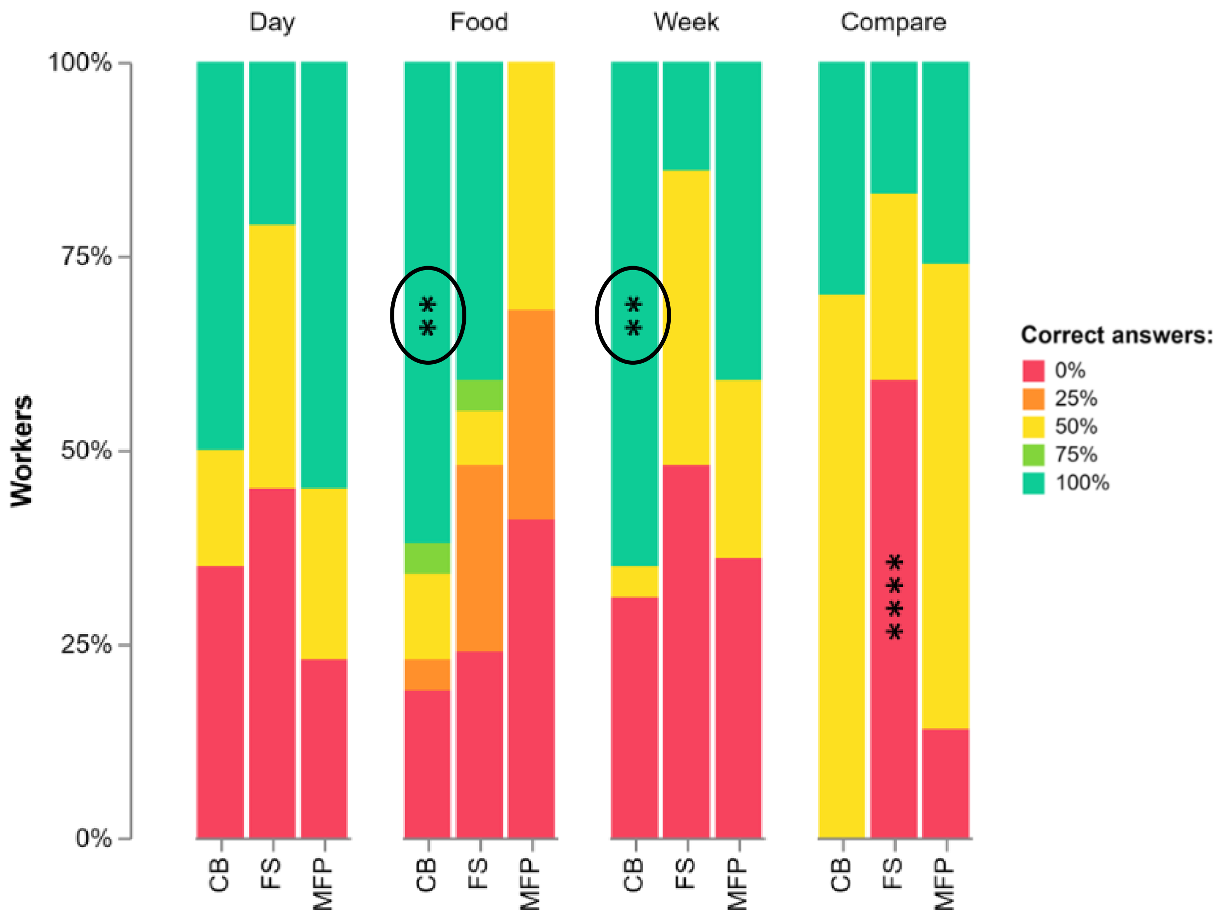
- Results for CB:



CB = Chatbot; FS = FatSecret; MFP = MyFitnessPal

Quiz scores

- Results for CB:
  - Positive association with:
    - Scoring 100% in food analysis
    - Scoring 100% in week analysis



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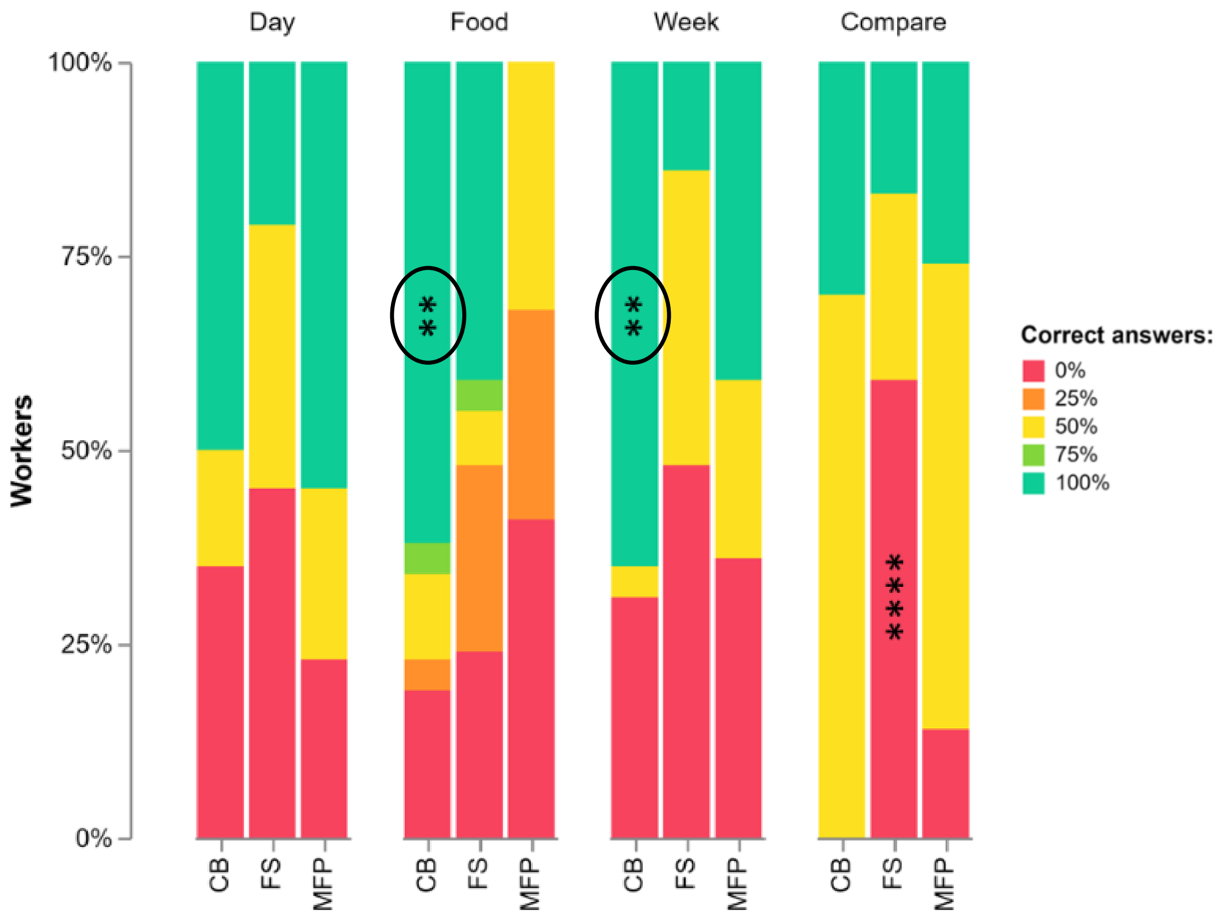
Quiz scores

- Results for CB:
  - Positive association with:
    - Scoring 100% in food analysis
    - Scoring 100% in week analysis
  - Negative association with:
    - Scoring 0% in weeks comparisons



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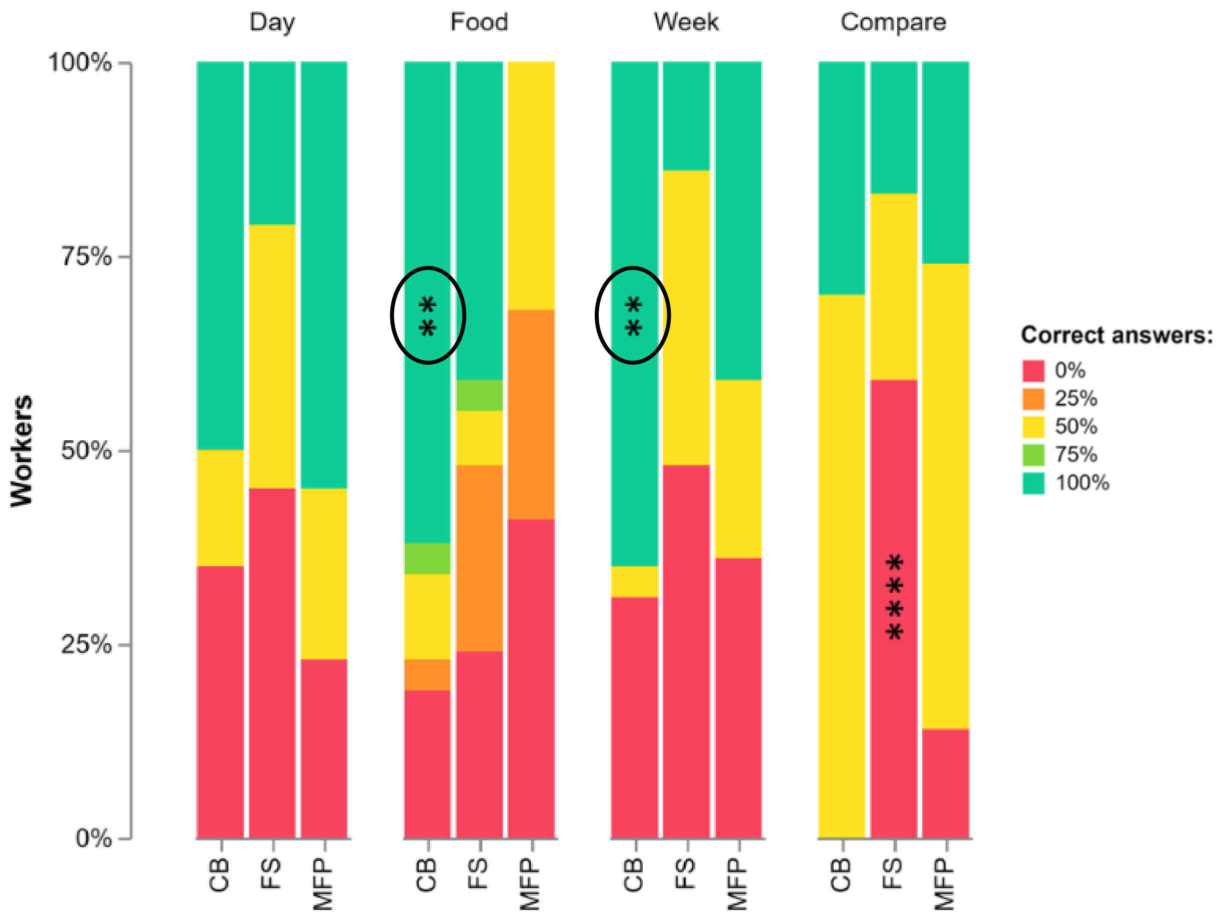
Quiz scores

- Results for CB:
  - Positive association with:
    - Scoring 100% in food analysis
    - Scoring 100% in week analysis
  - Negative association with:
    - Scoring 0% in weeks comparisons

- Results for FS:



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Quiz scores

- Results for CB:
  - Positive association with:
    - Scoring 100% in food analysis
    - Scoring 100% in week analysis
  - Negative association with:
    - Scoring 0% in weeks comparisons

- Results for FS:
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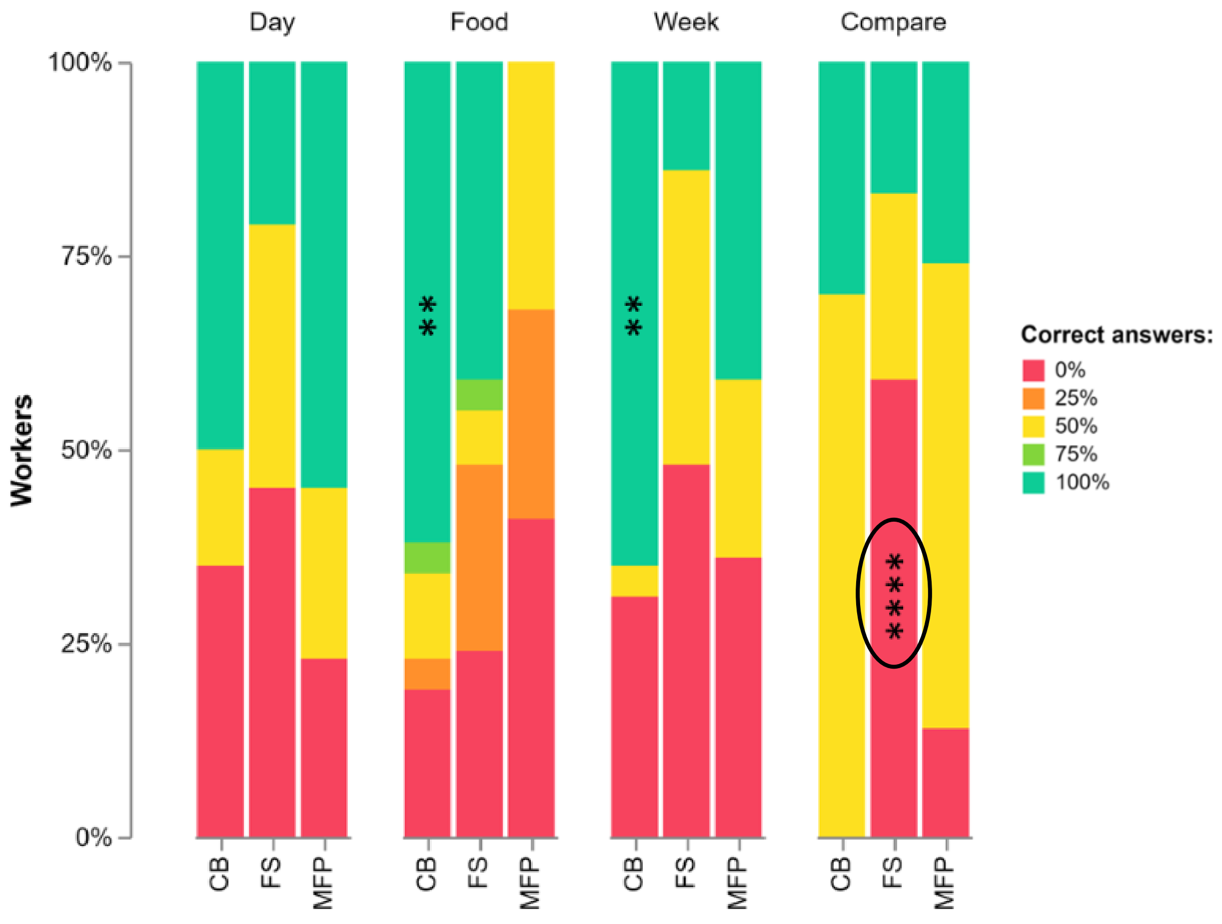

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Quiz scores

- Results for CB:
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  - Negative association with:
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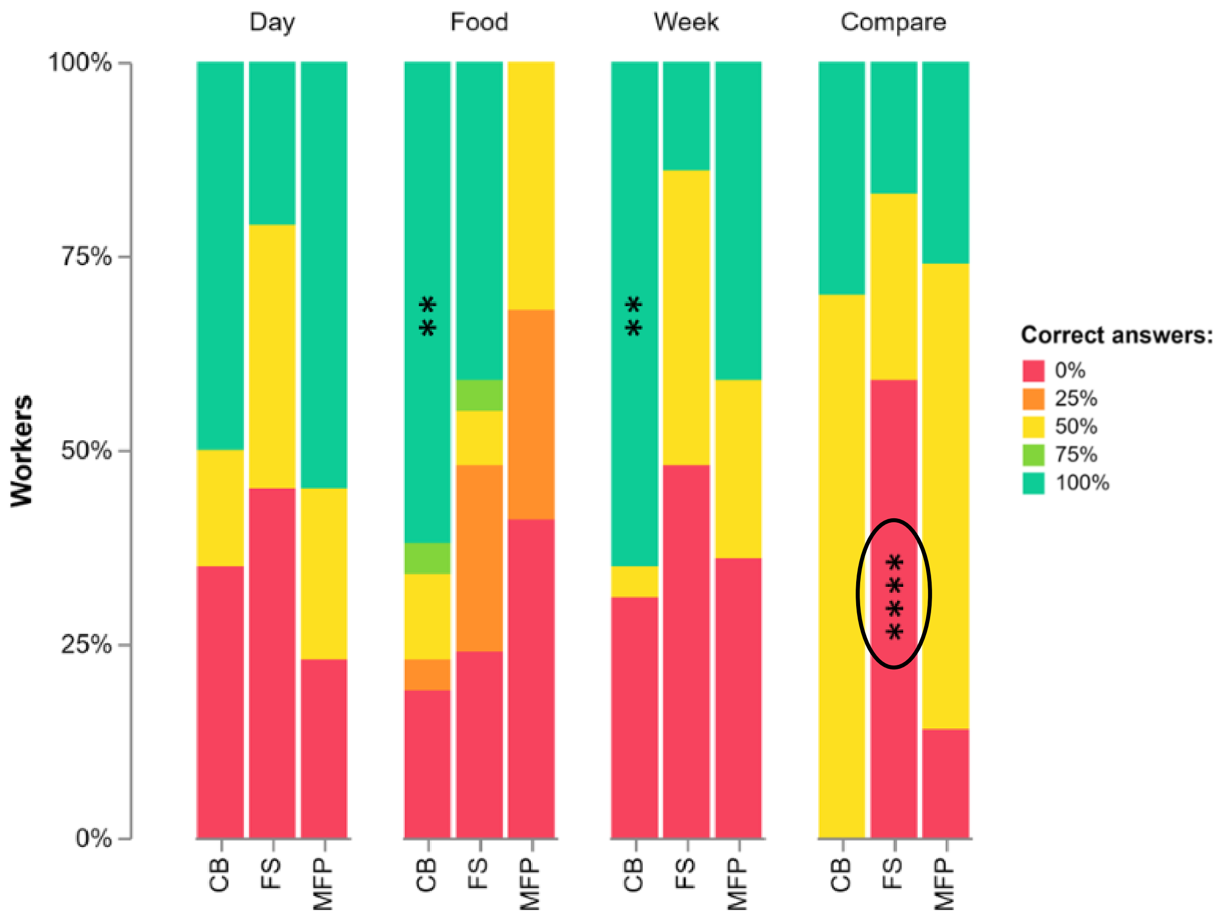
- Results for FS:
  - Positive association with:
    - Scoring 0% in weeks comparison
- Results for MFP:



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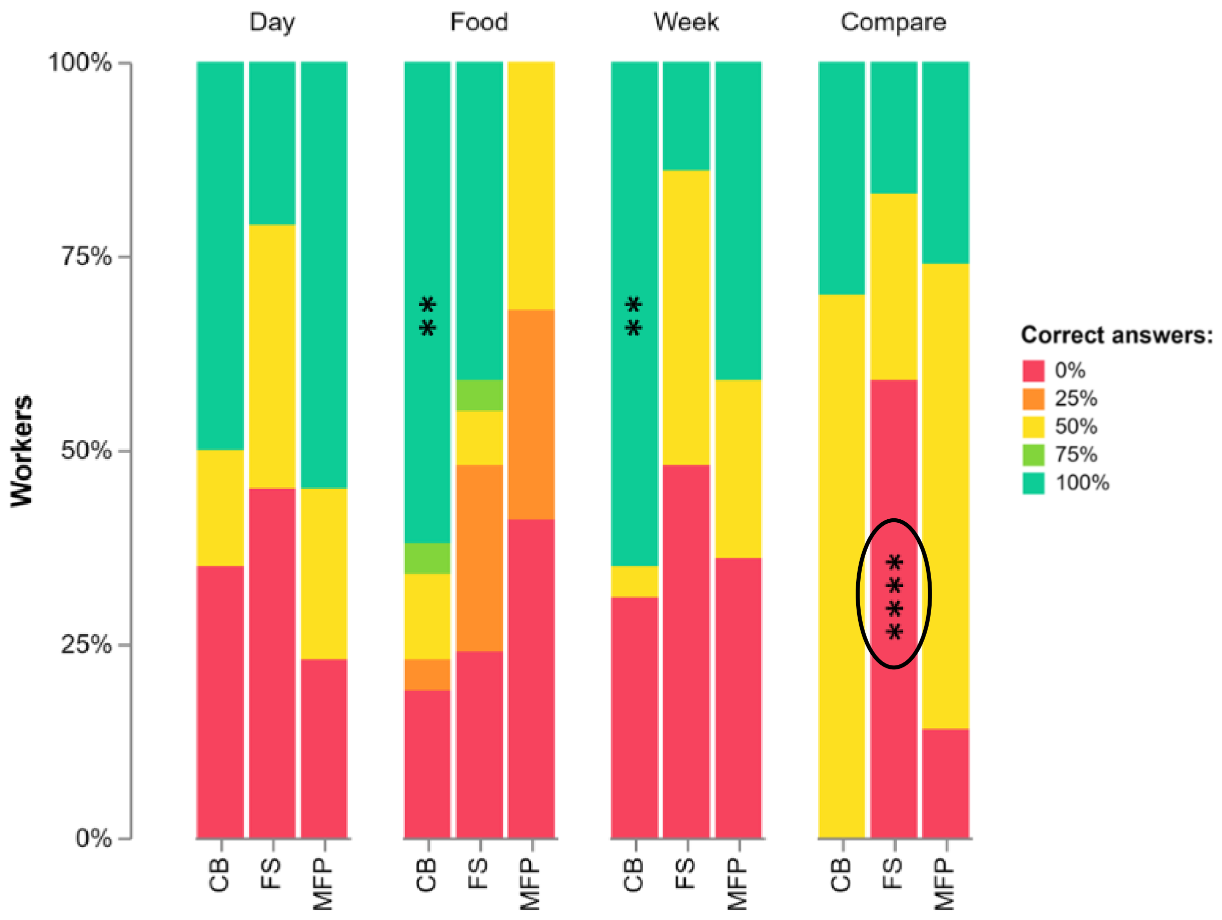
Quiz scores

- Results for CB:
  - Positive association with:
    - Scoring 100% in food analysis
    - Scoring 100% in week analysis
  - Negative association with:
    - Scoring 0% in weeks comparisons

- Results for FS:
  - Positive association with:
    - Scoring 0% in weeks comparison

- Results for MFP:
  - Negative association with:
    - Scoring 100% in food analysis



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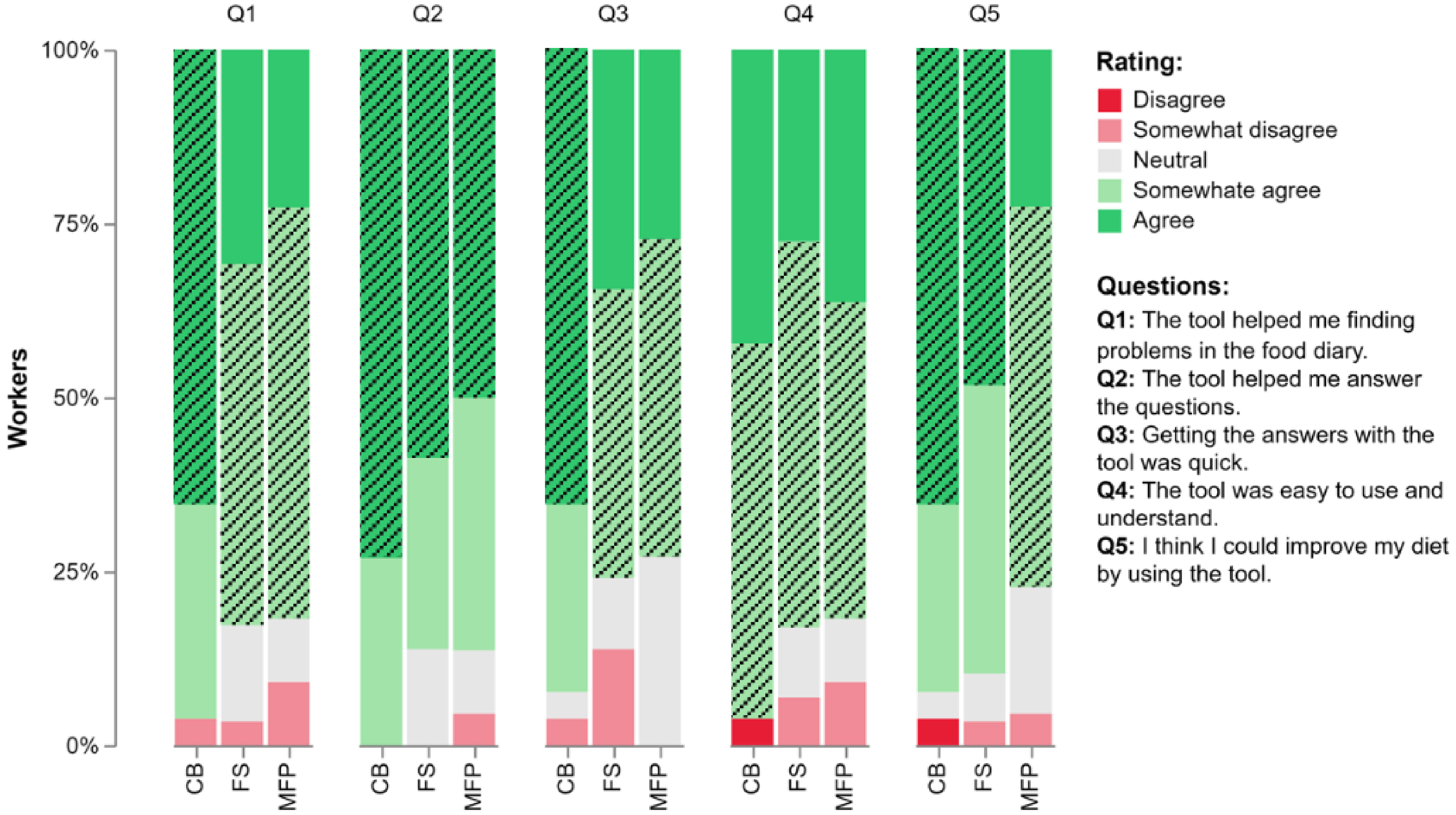
Perception of the tool



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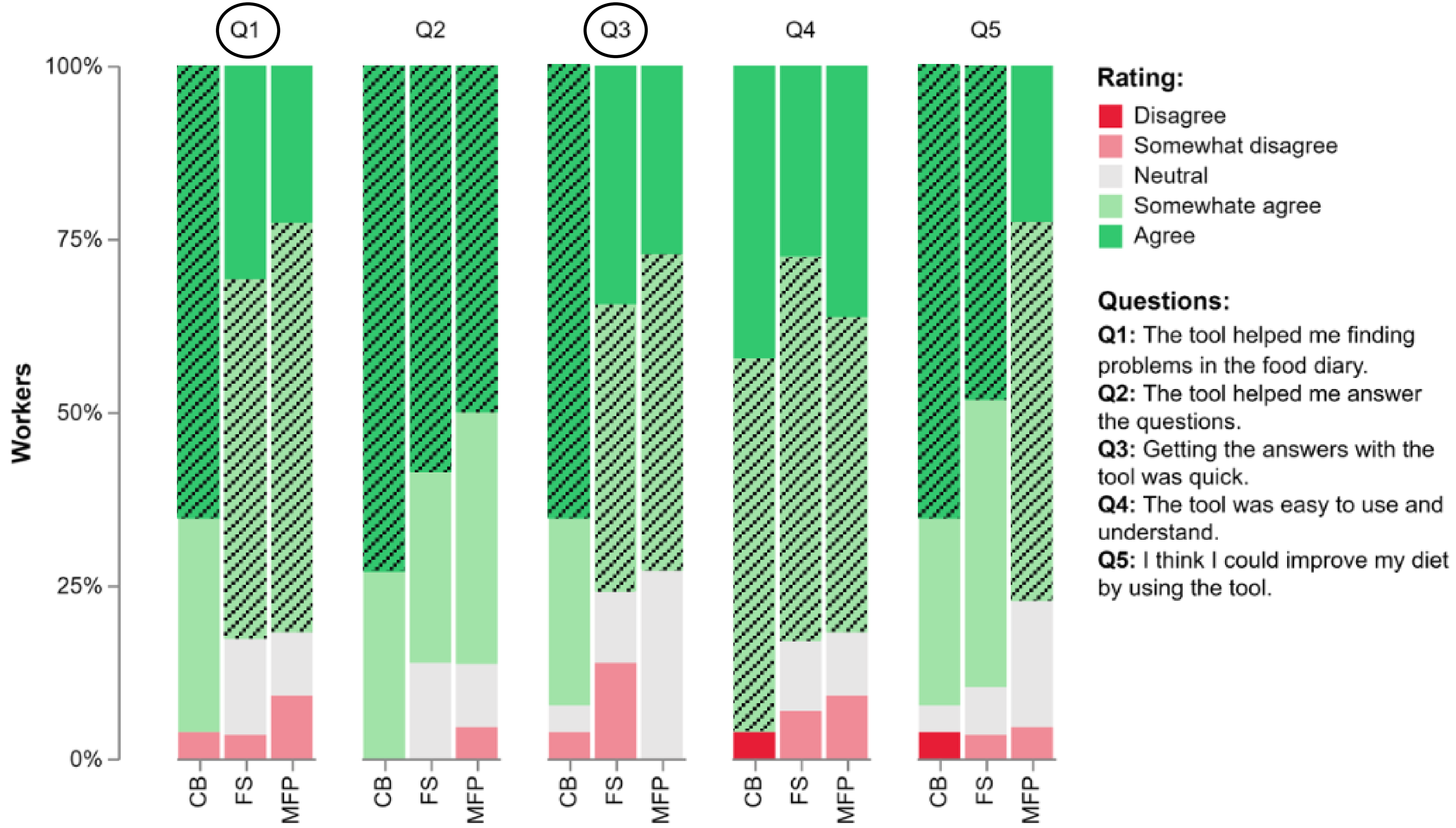

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Conclusions

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- We evaluated the effect of text and charts combination on informativeness in the conversational scenario, for diet coaching.

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- Our results on informativeness:

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Thank you!

Questions?

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PHIL HUMANS