A Motivating Social Robot to Help Achieve Cognitive Consonance During STEM Learning

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e wor s An iet Learne Helplessness Motivation Social Agenc Cognitive Consonance

Abstract In this paper we show that cognitive consonance coul be easure using the perceive cognitive consonance uestionnaire that we present in this paper or using three ifferent constructs which are the prospect an iet an learne helplessness e use ifferent otivating agents an we veri e whether the stu ent s otivation woul increase too In the secon stu we easure the cognitive consonance using the relate uestionnaire an the three constructs that we proofe that the help on easuring the cognitive consonance uring the rst stu This etho is calle the triangulation an help us to a e sure that the cognitive consonance has trul increase or not when we anipulate the otivation construct Finall since cognitive consonance increase when we use a otivating agent we eci e to investigate which of three agents a teacher a tablet or a robot a lea to better otivation outco e an thus a help the stu ent to strive for answering an focusing on the if cult scienti c uestions Results show that using a robot is the best solution that a increase the stu ent s otivation an help hi her to a opt a positive attitu e change on a long ter basis while the stu ent starts to concentrate on the if cult uestions rather than u ping to the eas ones

1 INTRODUCTION

The el of social robots has grown into an e tensive bo of literature over the past ears with a wi e variet of approaches for e tracting hu an patterns an o eling robots s ills Robots operate as partners peers or assistants in a range of tas s such as with autistic chil ren occanfuso an O ane 2011 ainer et al 2014 at ho es[1] in hospitals ilge an Forli i 2008 or for having fun e g the robotic to s fro owwee[2] etc Another role that a robot can pla is the role of a otivating agent to o if cult tas s e g solving a if cult e ercise Motivating a stu ent a increase the stu ent s strive for cognitive closure[3] while oing if cult e ercises Man stu ies fro HRI tac le the fact of how to affor the robot with the abilit to otivate people in an application el s such as at school S a r an Mutlu 2012 as stor -tellers Ha et al 2015 or as inciters to conserve energ Ha an Mi en 2014 etc Different points were investigate in other HRI stu ies such as the esign strategies to i prove patient otivation uring robot-ai e rehabilitation Colo bo et al 2007 the effect of robot appearance t pes on otivating onation i et al 2014 the role of the sociall assistive robot in otivating ol er a ults to engage in ph sical e ercise Fasola an Mataric 2013 etc

However to the best of our nowle ge no concern was pai to the serious con icts that stu ents encounter at schools while learning science technolog engineering an athe atics STEM an the social robot e otivating role that can be pla e The con icts e erging fro solving if cult STEM e ercises a lea to an increase an iet an learne helplessness Fincha et al 1989 An iet refers to the e tent to which an e ercise causes fear an reluctance fro the stu ent s behalf Learne helplessness refers to a isruption in otivation effect an learning when the stu ents feel the o not have an control of the outco e

Conse uentl it is i portant to give a serious attention to the issue of the angerous conse uences of cognitive con ict while oing a STEM if cult e ercise Cognitive con ict is a isco fort that one in general e periences when a stu ent hol s beliefs at-

[1]Roo ba iRobot http www irobot co
[2]Li ite ow ee roup http www wowwee co
[3]The cognitive closure can be e ne as the hu an s esire to eli inate a biguit an arrive at e nite conclusions

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titu es or behaviors that are at o s with one another the ratio between issonant an consonant preconceptions about a STEM notion As a result we nee to grant the social robot with the abilit to follow closel the stu ent s engage ent an use otivating strategies that a ecrease the cognitive con ict students a get through while solving STEM e ercises

In the current research we investigate how cognitive consonance-relate characteristics i e otivation prospect[4] an iet an learne helplessness affect people s appraisal of cognitive consonance More speci call our ain focus is un erstan ing the role of otivation in the cognitive consonance perception process In the rst stu e plo ing a large range of athe atical e ercises we test the relationship between cognitive consonance an the triplet prospect an iet an learne helplessness In the secon stu we e a ine the role of appraisals of otivation as the relate to appraisals of prospect an iet learne helplessness an perceptions of cognitive consonance More speci call we test whether the effect of otivation on perceptions of cognitive consonance is e iate b appraisals of the cognitive consonance-relate characteristics In the thir stu we co ple ent the correlational approach use in the secon stu to un erstan the role of otivation b e peri entall anipulating agent level s of agenc an we verif whether it is better to use a hu an a robot or a tablet to better increase the stu ent s otivation If the stu ent s otivation is increase his perfor ance uring stu woul increase too He She will have better i plicit an e plicit attitu es behaviors an woul be please while oing if cult e ercises without u ping fro the if cult e ercise to the eas one

2 BACKGROUND

In our o ern- a societ e ucation pla s a vital role Motivating the stu ent s while ac uiring new nowle ge is one of the ost often use strategies ai e at re esigning the classroo environ ent in such a wa as to re uce the poor aca e ic performance lac of otivation for school loss of interest in wor an poor relationships with peers or teachers

hen cognitive issonance occurs ifferent counter-attitu inal actions can be chosen b the human an which are an active attitu e change with a new attitu e create [5] a belief change b ini i ing the i portance of the cognitive issonance[6] or a perception change b getting a new infor ation to support one s previous ecision[7] hen the stu ent e periences cognitive issonance he will strive to ecrease the inconsistenc b choosing one of the escribe counter-attitu inal actions e want that students get ri of their ba attitu es of s ipping the if cult STEM e ercise The new for e attitu e shoul be highl accesse so that it can be store on a long ter basis on the stu ent s cognitive iser[8]

3 FIRST STUDY

3.1 Method

Different groups of participants in epen entl trie to answer a set of athe atical s all uestions inclu e in a ui an then evaluate e ercises either on cognitive consonance-relate characteristics i e prospect an iet an learne helplessness or on perceive cognitive consonance e e pecte that appraisals of prospect woul be positivel associate with perceive cognitive consonance an that appraisals of learne helplessness an an iet woul be negativel associate with perceive cognitive consonance e e plo e a within-sub ects esign in which participants evaluate a set of 100 s all athe atical uestions The epen ent variables were prospect an iet an the learne helplessness Our sa ple co prise 31 participants 15 ales an 16 fe ales Mean age 16 03 SD age 2 45 with age range 13 5-19 5 ears The participants were stu ents in Ibnou Sina College Figure 2

3.2 Materials and Measures

The current stu co prise 100 athe atical uestions set b an e perience teacher e easure ifferent co ponents which are the prospect the an iet an the learne helplessness using slight a aptations of the ite s use in the literature The ifferent co ponents were each easure using three ve-point response categor for at ite s ranging for e a ple fro 1 strongl isagree through 3 neutral to 5 strongl agree e calculate the average of the ifferent ite s for each easure an use these ag-

[4] rospect is t picall e ne as the e tent to which the e ercise s easiness allows the stu ent to continue resolving the e ercise

[5] The stu ent thin s that he has to change his attitu e of avoi ing if cult e ercises

[6] After all science learning is not that i portant Man other tas s coul be one

[7] The stu ent thin s that the answer affor e b the boo is incorrect

[8] easuring the i plicit an e plicit attitu es we can verif whether it was establishe for a long ter basis

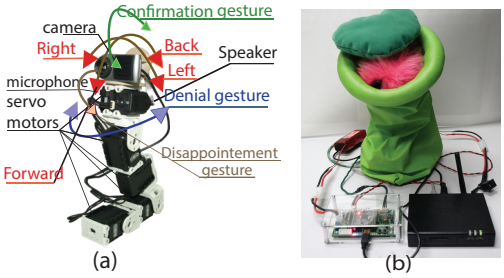

Figure 1 a A close-up picture of RO OMO b RO OMO overall esign

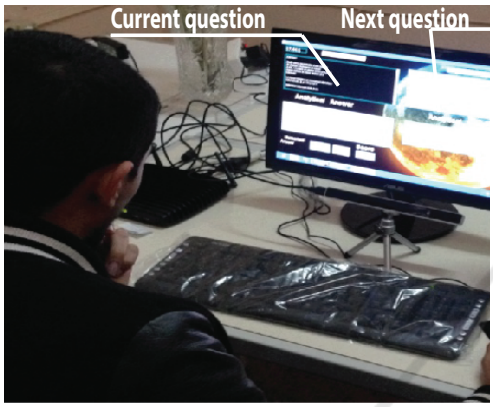

Figure 2 The rst stu overall e peri ent setup

gregate scores in our anal ses $\alpha_{cognitive_consonnance} = .91$ $\alpha_{prospect} = .95$ $\alpha_{anxiety} = .69$ an $\alpha_{learned_helplessness} = .79$

3.3 Results and Discussion

All of the reporte anal sis are perfor e on the aggregate easure scores for each athe atical uestion across all participants Descriptives for the easures of our epen ent variables are presente in Table 1 e rst e a ine correlations between cognitive consonance an the easures of the consonance-relate characteristics prospect an iet learne helplessness Table 2 As e pecte perceive cognitive consonance was positivel correlate with prospect r 71 $p \leq .001$ an negativel correlate with an iet r - 65 $p \leq .001$ an learne helplessness r - 85 $p \leq .001$ These results show that appraisals of prospect an iet an learne helplessness are highl associate with the perception of cognitive consonance even when the ratings of perceive cognitive consonance an the cognitive consonance-relate situation characteristics are obtaine in epen entl fro each other e t we e a ine the correlations a ong the easures of the cognitive consonance-relate characteristics Table 2 rospect was negativel correlate with an iet r - 83 $p \leq .001$ an learne helplessness r - 72 $p \leq .001$ an an iet was positivel correlate with learne helplessness r 73 $p \leq .001$

Table 1 Descriptives for the easures of cognitive consonance prospect an iet an learne helplessness

	M	SD	Min	Ma
Cognitive Consonance	3 16	0 70	1 25	4 31
rospect	2 84	0 71	1 25	4 22
An iet	3 12	0 55	1 98	4 56
Learne Helplessness	3 23	0 63	2 04	4 87

e t we use ultiple regression anal sis to test whether appraisals of the cognitive consonance-relate situation characteristics prospect an iet learne helplessness pre icte appraisals of perceive cognitive consonance e foun that the three pre ictors accounte for appro i atel 75 of the variance in perceive cognitive consonance with F 3 96 94 77 $p \leq .001$ R^2 75 an R^2_{adj} 74 As e pecte appraisals of both an iet an prospect signi cantl pre icte perceive cognitive consonance Table 3 An iet was not foun to predict perceive cognitive consonance to a signi cant e tent Table 3

One proble with ultiple regression anal sis is that the fail to appropriatel partition the variance when the pre ictors in the o el are highl correlate Thus an assess ent of the relative contribution of the three pre ictors to cognitive consonance evaluation characteristics[9] was i pe e b the high ulti collinearit between these pre ictor variables in our ata Table 2 Hence we e plo e the *rego*[2] pac age available for Stata that utili es Shaple value eco position to eco pose the overall o el goo ness-of- t in e in our case R^2 into in epen ent contributions of the pre ictor variables hile appraisals of an iet were not foun to signi cantl pre ict perceive cognitive consonance in our ultiple regression anal sis the results fro the R^2 eco position reveale that an iet contribute onl slightl less to the overall variance as co pare to prospect Table 3 In line with the ultiple regression anal sis the results of the R^2 eco position in icate that of the three pre ictors in our o el appraisals of learne helplessness contribute ost strongl to the overall variance e teste the robustness of our regression o el b perfor ing 100 split

[9]Cognitive consonance characteristics evaluation is accounte for b prospect perceive stu ent s esire to continue with solving the athe atical e ercises an iet perceive stu ent s an iet after solving a athe atical e ercise an learne helplessness a situation in which a stu ent believes that his efforts are going for waste an that he got a proble atic cognitive proble that prevent hi fro un erstan ing athe atics

Table 2 Correlations between easures of cognitive consonance prospect an iet an learne helplessness ote $p \leq .001$

	Cognitive Consonance	rospect	An iet	Learne Helplessness
Cognitive Consonance	-			
rospect	71	-		
An iet	- 65	- 83	-	
Learne Helplessness	- 85	- 73	- 73	-

Table 3 OLS ultiple regression results with the eco position of R^2 in of total R^2 Lower level LLCI an upper level LCI con ence intervals base on bootstrapping with 5000 resa ples

	Multiple Regression			Deco position of R^2		
	eta	t	p	Shaple R^2	LLCI	LCI
rospect	0 26	2 71	0 008	25 58	18 14	32 3
An iet	0 12	1 26	0 211	19 1	13 04	27 2
Learne Helplessness	-0 75	-9 49	$p \leq .001$	55 32	43 64	67
Observations	100					
Full o el R^2	0 75					

sa ple vali ations In each instance the original 100 sti uli were ran o l assigne to two groups of e ual si e The regression weights of prospect an - iet an learne helplessness obtaine fro a ulti- ple regression anal sis on the rst group were then use to calculate pre icte scores for perceive cog- nitive consonance of the secon group In the last step the correlation between the observe scores an the pre icte scores for the secon group was calcu- late The results show a high robustness of our re- gression o el across the 100 split sa ple vali ations $M_r = .86$ $SD_r = .033$ $M_{R^2} = .74$

Across our large sa ple of representative envir- on ents our regression o el pre icting perceive cognitive consonance fro appraisals of prospect an iet an learne helplessness accounte for ap- pro i atel 75 of the variance in cognitive con- sonance u g ents The o el was foun to be ro- bust across 100 split sa ple vali ations As e pecte both prospect an an iet were i enti e as signif- icant pre ictors of perceive cognitive consonance Moreover our n ings are in line with previous n - ings in icating that appraisals of learne helplessness are ost strongl associate with perceive cognitive consonance In contrast to previous n ings an iet was not foun to a e a signi cant contribution to perceive cognitive consonance in our o el

4 SECOND STUDY

e e ten e our investigation to the role of a o- tivating agent s presence in the cognitive consonance appraisal process b inclu ing participants appraisals of the agent in our regression o el Our goal is to enhance the stu ent s aca e ic s ills e assu e that the presence of a otivating agent that a con- vince the stu ent to continue resolving the if cult STEM e ercise even when he she faces a cognitive issonance situation a enhance the stu ent s ap- preciation of the STEM science technolog engi- neering an athe atics sub ects The agent is sup- pose to encourage the stu ent to achieve the tas of answering the athe atical set of uestions In gen- eral when a stu ent faces a if cult STEM e ercise an he she n s out that his her answer is incorrect he she will u p to the ne t e ercise b a opting a belief change as a counter-attitu inal behavior If he she opts for re oing the e ercise that was previousl answere incorrectl without putting so uch effort while re oing it so that he she gets to the correct an- swer we sa that the stu ent chooses a perception change as a counter-attitu inal behavior e want that the stu ent chooses the attitu e an behavior change as a counter-attitu inal behavior after being stric en b the cognitive issonance so that he she learns ef- cientl the STEM sub ects e use ifferent t pes of agents that a help the stu ent to overco e the cognitive issonance which are a frien of the sa e age a teacher a robot RO OMO a tablet The ifferent agents use three ifferent i e strategies to otivate the stu ent which are the oor in face[10] an labeling techni ues

e e pect that an enlightening otivating agent a e power the stu ent to a e an eas shortcut re uce the cognitive wor loa an follow the o- tivating essage s gui elines consisting on re oing the STEM uestion that was previousl answere in- correctl rather than a opting a perception or belief

[10]Here we nee to start b an in ate re uest an then re- treat to a s aller re uest After the rst re uest is refuse the hu an will feel that he she nee s to change his her opinion since the initial re uest has change a atter of reciprocit

change strategies

The general ai of the secon stu is to e a - ine the path through which appraisals of the otivation affor e b the agent in a situation that lea s to a cognitive issonance affect people s appreciation an cognitive consonance e e plo e a si - ilar esign as the previous stu an as e participants to evaluate the ifferent otivating agents that were co bine with the set of athe atical uestions use in the previous stu e assign ran o l for each uestion one of the 3 ifferent agents Following previous n ings fro the literature we e pecte to n that appraisals of the otivating agents woul be positivel associate with the appraisals of the cognitive consonance obtaine in the previous stu e e pecte that this effect of perceive otivation affor e b the agent on perceive cognitive consonance woul at least partiall be e iate b the effect of perceive otivation affor e b the agent on the cognitive consonance-relate characteristics i e prospect an iet an learne helplessness

4.1 Method

e e plo e a within-sub ects esign in which participants evaluate the perceive otivation affor e b the agent while the are resolving the athe atical uestions The sa ple co prise 46 participants 22 ales an 24 fe ales $M_{age} = 30.37$ $SD_{age} = 14.51$ age range 18 - 62 ears The participants were registere in Ibnu Sina College

4.2 Materials and Measures

e use the sa e set of athe atical uestions use in the previous stu erceive otivation affor e b the agent was easure using ifferent ve-point response categor for at ite s ranging for e a ple fro 1 ot intereste through 3 neutral to 5 Intereste [11] e calculate the average of the ite s for each athe atical uestion an use this aggregate score in our anal sis α 87

4.3 Procedure

The proce ure an con itions of the secon stu were analogous to those of the previous one e cept that while answering each uestion of the athe atical ui an agent spea s out lou a otivating essage so that we can ensure that the stu ent eeps on answering the ui even if the uestions are if cult In fact if the uestion is if cult an the stu ent recogni es that his answer is incorrect he a feel isappointe His athe atical preconceptions are efeate an he e periences a iscrepanc between what he believes an the answer In such a case a successfull otivate stu ent woul answer the sa e uestion that was previousl answere incorrectl All participants respon e to the ite s of the perceive otivation uestionnaire

4.4 Results and Discussion

e a e the aggregate perceive otivation affor e b the agent easure s score as a new variable to the ata set containing the prospect an iet learne helplessness an perceive cognitive consonance obtaine in the previous stu Descriptives for the easure of perceive otivation affor e b the agent easure are presente in Table 4 e rst e - a ine the correlations between the perceive otivation affor e b the agent s easure an the easures fro previous stu Table 5 e foun that perceive otivation affor e b the agent was positivel correlate with perceive cognitive consonance r 47 $p \leq .001$ an prospect r 76 $p \leq .001$ an negativel correlate with an iet r - 48 $p \leq .001$ an learne helplessness r - 49 $p \leq .001$

To test whether appraisals of the perceive otivation affor e b the agent pre icte appraisals of perceive cognitive consonance we perfor e a regression anal sis The regression o el accounte for appro i atel 20 of the variance in perceive cognitive consonance with F 1 98 27 28 $p \leq .001$ R^2 22 an R^2_{adj} 21 As e pecte perceive otivation affor e b the agent was signi cantl relate to perceive cognitive consonance β 48 t 5 22 $p \leq .001$ The regression o el was o eratel robust across 100 split sa ple vali ations $M_r = .48$ $SD_r = .079$ $M_{R_2} = .22$

e t a ultiple regression anal sis was con- ucte with both the perceive otivation affor e b the agent an the cognitive consonance-relate characteristics prospect an iet learne helplessness as pre ictors The co bination of easures signi - cantl pre icte perceive cognitive consonance with F 4 95 72 31 $p \leq .001$ R^2 75 an R^2_{adj} 74 However while the easures of the cognitive consonance-relate characteristics pre icte signi - cantl over an above the perceive otivation affor e b the agent easure with R^2 change 54 F 3 95 68 53 $p \leq .001$ the perceive otivation affor e b the agent easure i not pre ict signif- icantl over an above the easures of the cognitive consonance-relate characteristics with R^2 change 01 F 3 95 1 99 p 161 ase on these results perceive otivation affor e b the agent appears to

[11] https goo gl for s Tn Le44 IM 12

Table 4 Descriptives for the easure of perceive otivation affor e b the agent

	M	SD	Min	Ma
erceive otivation affor e b the agent	perceive otivation affor e b the agent	2 91	0 69	1 26

Table 5 Correlations between the easures of perceive perceive otivation affor e b the agent of the current stu an the easures cognitive consonance prospect an iet an learne helplessness of the previous stu $p \leq .001$

	erceive Consonance	rospect	An iet	Learne Helplessness
erceive otivation affor e b the agent	47	76	- 48	- 49

Table 6 Su ar of e iation anal sis results 95 con ence intervals base on bootstrapping with 5000 resa ples Reporte con ence intervals are bias correcte $p \leq .001$

In epen ent variable	total effect	irect effect	e iator	a	b	in irect effect	LLCI	LCI
erceive otivation affor e b the agent	476	-0 127	prospect	787	41	0 322	0 103	0 593
			an iet	- 381	0 241	-0 092	-0 24	0 02
			learne helplessness	- 447	- 833	0 372	0 214	0 574

offer little a itional pre ictive power be on that contribute b appraisals of prospect an iet an learne helplessness

hile our results show that appraisals of the perceive otivation affor e b the agent are inee associate with perceive cognitive consonance the lac of pre ictive power over the cognitive consonance-relate characteristics an the e iu to high correlations between perceive otivation affor e b the agent an the cognitive consonance-relate characteristics suggest that this association a be e iate b changes in appraisals of prospect an iet an learne helplessness e use the bootstrapping etho for ultiple e iation b reacher an Ha es ristopher an Ha es 2008 to test whether the effect of perceive otivation affor e b the agent on perceive cognitive consonance was e iate b appraisals of the cognitive consonance-relate characteristics See Table 5 for a su ar of the results of our e iation anal sis

The results of the e iation anal sis show that perceive otivation affor e b the agent is positivel relate to prospect an negativel relate to an iet an learne helplessness Our results also con r the ultiple regression anal sis showing that perceive otivation affor e b the agent total effect prospect an an iet were signi cantl relate to perceive cognitive consonance The bootstrapping etho provi es esti ates an bias correcte con ence intervals for the in irect effects in the o el If the con ence intervals o not contain ero the esti ate of the in irect effect is signi cant Following this criterion the results show that both the in irect effect of prospect an an iet were signi cant The in irect effect of an iet was not significant I portantl our results show that if we account for the relation between perceive otivation affor e b the agent an appraisals of the cognitive consonance-relate characteristics the effect of perceive otivation affor e b the agent on perceive cognitive consonance irect effect is no longer signi cant suggesting that this effect is full e iate b changes in appraisals of prospect an an iet

In su our results show that while perceive otivation affor e b the agent signi cantl affects the perceive cognitive consonance These n ings provi e evi ence for the i ea that the otivation affor e b the agent frien robot teacher tablet in uences cognitive consonance perceptions in irectl through its effect on those cognitive consonance characteristics prospect an iet an learne helplessness that are i portant for the cognitive consonance appraisal process

5 THIRD STUDY

As otivation has a irect effect on the cognitive consonance an we have opte to use ifferent agents in the previous stu stu 2 e eci e to verif which of the three ifferent agents t pe a lea to the highest otivation perception

5.1 Method

66 Tunisian stu ents participate in this e peri ent 17-19 ears fro Farhat Hache College articipants were ebriefe which a help us to evaluate their planne attitu e[12] articipants were tol that the woul resolve so e e ercises to help evaluate a new robot platfor Once a stu ent enters to the roo he she was as e to o the calibration e e tribe an then starts answering the e ercises e infor the stu ent that he she can choose to u p to the ne t e ercise if the current one is if cult hen the

[12]This is to easure the stu ent s e plicit attitu e e ust as respon ents to thin about an report their attitu es

Table 7 A table showing the secon ain effect investigation results tablet vs robot tablet vs hu an an robot vs hu an

Factor	Comparison contrast (F, p-value)		
	Tablet vs robot	Tablet vs hu an	Robot vs hu an
leasure	149 3 <0 001 R	16 34 0 06	83 58 <0 001 R
IAT	21 92 <0 001 R	37 54 0 003 H	2 29 0 013 R
Cog Diss	136 8 <0 001 R	17 9 <0 001 H	88 5 0 04 R
uotient	26 09 <0 001 R	5 17 0 049 H	2 6 0 009 R
Loo s	84 4 <0 001 R	54 0 008 H	71 08 <0 001 R

stu ent feels that he she wants to leave the roo or when he she nishes the e ercises collection we than hi her an he she has to answer a post-e peri ent surve e ivi e our participants within sub ects esign e peri ent in a wa that we can guarantee that we have a counterbalance of the ata thereb re ucing the effect of the se uence of trials on the results

RO OMO generates the otivating speech that it is coor inate with the robot s convenient gestures bo an hea gestures an the right tone The oti-vating speech use b the ifferent t pes of agents follows the techni ue labeling techni ue As a re in er the labeling techni ue involves assigning a label to the in ivi ual an then re uests a favor that it is consis-tent with the label For e a ple telling to a stu ent I now ou are striving to success an eep insi e ou are har wor er In such case the stu ent has ore ten enc to live up with the positive label Thus one wa to a e a hu an pro uce the esire behavior is to assign positive label to hi her so that ou can rive hi her to live up with that label an aintain that positive consistenc that serves the public i age of the person as well as his her self-estee There are four con itions the stu ent ta es part in which are the baseline con ition o otivating essage is af-for e con ition 1 the tablet affor s the otivating essage con ition 2 the robot affor s a otivating essage an con ition 3 the hu an affor s a oti-vating essage Each two a s the stu ent co es to the classroo to re o another set of uestions with a new set of otivating essages while we change the otivating source

5.2 Materials and Measures

After the e peri ent nishe the stu ent has to an-swer uestionnaires such as the e plicit attitu e an-tos an er ins 2013 the i plicit attitu e i plicit association test IAT antos an er ins 2013 the cognitive issonance cogn iss Levin et al 2013 an the perceive pleasure s level ra le an Lang 1994 e consi ere other epen ent variables

The uotient u ber of ti es the user re oes incorrect uestion b the nu ber of ti es the user a es an error It gives an i ea about when has the stu ent a ten enc to re o incorrect uestions to strive for science learning rather than u ping fro one uestion to another

Loo s nu ber of ti es the user wells with e e ga e between the 2 uestions

5.3 Results and Discussion

The otivating essage source agenc s level ha a ain effect in ter s of all the constructs with a -value <0 001 Table7 shows that there were signi cant ifferences between the robot an tablet con itions with higher results in the robot s con i-tion for all the constructs Also Table7 shows that using a robot as a otivating source in co pari-son to using a hu an increases cog iss F 88 5 p-value 0 04<0 05 R an loo s F 71 08 p-value<0 001 R There were statistical ifferences in ter s of pleasure with higher results in the robot s con ition rather than in the hu an s con-ition F 83 58 p-value<0 001 R IAT F 2 29 p-value 0 013<0 05 R an uotient F 2 6 p-value 0 009<0 01 R

6 CONCLUSION

Motivating a stu ent is co onl associate with a positive effect on the e perience of cognitive conso-nance et little is nown about the ps chological processes through which perceive otivation a e ert its in uence on people s cognitive consonance perceptions e investigate the role of otivation in cognitive consonance perception using a wi e range of ifferent agents t pes Across two stu ies we teste the i ea that otivation in uences appraisals of cognitive consonance through its effect on appraisals of cognitive consonance-relate characteristics i e prospect an iet an learne helplessness The ore an agent otivates the stu ent the ore he she gets clear i eas an scores high in ter s of cognitive consonance Finall we co pare ifferent agents t pes to verif which one of the a lea to better otivation an thus higher cognitive consonance Re-sults show that using a robot a lea to better results

in ter s of perceive otivation Thus the stu ents having a robot as a otivating source a opt a positive counter-attitu inal behavior attitu e an behavior change while the strive to answer the STEM uestions that were previousl answere incorrectl

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