How (not) to inform patients about drug use:

Use and effects of negations in Dutch patient information leaflets

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Running head (37 characters)

USE AND EFFECTS OF NEGATIONS IN PILS

Key words

Patient information leaflets; drug information; patient education; language; negations

Key points

- Negations are often used in Dutch patient information leaflets (PILs) as 21.0% of clauses in our corpus of PILs contained at least one negation.
- Negations decrease actual comprehension, subjective comprehension, PIL appreciation and medical-adherence intentions.
- The reduction in medical-adherence intentions is driven by the decrease of subjective, and not actual comprehension.

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Abstract

Purpose

Under EU regulations, patient information leaflets (PILs) are required to be clear and understandable. Negations (e.g., *not, no*) are a linguistic aspect that may impact PIL comprehension, yet go unmentioned in these regulations. We conducted two studies to determine (1) how negations are used in Dutch PILs (Study 1) and (2) the effects of negations on readers (Study 2).

Methods

Study 1 was a content analysis of 30 PILs of different brands of pollinosis drugs, half of which were freely available in drugstores and half only by physician prescription. We mapped negation use in PIL sections on 'proper usage' and 'potential side effects'. Study 2 was an experiment in which participants (N= 80, M_{age}= 33.19 years, SD_{age}= 13.66; 76.3% female) were presented with one of two PIL texts on proper drug usage. Texts were identical except for the use of negations. After reading, participants answered questions about comprehension, PIL appreciation and medical adherence intentions.

Results

Study 1 demonstrates that negations are often used in PILs as 21.0% of clauses contain at least one negation. This number is higher in sections related to potential side effects than proper usage. Study 2 demonstrates that negations decrease both actual and subjective comprehension. Negations also decrease PIL appreciation and medical-adherence intentions. The reduction in medical-adherence intentions is driven by the decrease of subjective, and not actual comprehension.

Conclusions

In general, participants prefer PILs that contain clear and comprehensible language. To increase comprehensibility, PIL designers should refrain from using negations as much as possible.

Key words: Patient information leaflets, drug information, patient education, language, negations

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Introduction

Medicinal products for human use available in the EU should be accompanied by patient information leaflets (PILs) with proper information about the drugs.[1,2] Unfortunately, many such PILs suffer from readability problems and patients find the information difficult to comprehend.[3-5] The Directive of the Council of the European Union aims to remedy this problem and states that PILs "must be written and designed to be clear and understandable, enabling the users to act appropriately, when necessary with the help of health professionals" (section 48.b.2 from [2], amending section 63.2 from [1]). The European Commission provides concrete guidelines to increase readability and patient comprehension of PILs.[6]

Current EU guidelines contain many useful tips for PIL designers[6] to maximize PIL comprehension in patients. After all, patients prefer PILs written in plain and comprehensible language.[7,8] Additionally, both case findings[9] and survey results[10] demonstrated that confusing PILs[9] or PILs with "insufficient information"[10] are associated with reduced patient compliance. Many of the EU guidelines provide concrete advice on the language that should be used in PILs, such as the recommendations to avoid long sentences and medical jargon.[6]

While these are valuable and important guidelines, they do not cover all potentially important language aspects. Indeed, studies from the field of communication science suggest that ordinary language elements, like negations, may reduce text comprehension as they carry additional meaning.[11] Negations (e.g., *not* as in *not dangerous*) are more indirect than affirmations (e.g., *safe*) and more difficult to comprehend.[12-14] Furthermore, experiments show

that negations provide implicit cues to expectancies by introducing concepts of opposite meaning.[15-16] For instance, a negation like 'not dangerous' may suggest that a drug at first was considered to be dangerous, while an affirmation like 'safe' does not carry this implication.

While, to the best of our knowledge, negations usage in PILs has not yet been studied, negations are commonly used in other medical genres, for instance in clinical reports describing diagnosis.[17-19] Furthermore, experimental research demonstrated that negations in doctor-patient interaction are not appreciated and reduce medical adherence intentions, especially for outcomes framed relatively moderately.[20] To replicate and extend such findings for PILs, this study aims to map prevalence of negation use in PILs (Study 1) and effects of negations in PILs (Study 2).

Study 1 is a content analysis mapping different negation types in Dutch PILs of drugs that are either generally available or only by physician prescription. First, negations can be divided into morphological and sentential negation types.[21,22] Morphological negations are words with prefixes that imply negation (like the prefix *un-* in words like *unhealthy*). Sentential negations are found on a sentence level and are further subdivided into explicit and implicit negations.[21] Explicit negations contain words like *no* or *not*. Implicit negations either refer to conventionalized mergers of *not* with a second word (as in *not ever* → *never*; *not anybody* → *nobody*) or to other words that suggest (partial) negation like *only* or *hardly* (e.g., *hardly* anybody got ill).

Study 2 is an experiment focusing on the effects of negations in PILs. Participants were presented with PILs containing either affirmations or negations. We test whether PILs with negations (vs. affirmations) indeed reduce comprehensibility and medical adherence intentions. Studies on information processing distinguish two comprehension types: (1) objective or actual

comprehension, which reflects what participants actually understood, (2) subjective comprehension, reflecting what participants think they understood.[23] We focus on both types.

Method

Both studies were conducted in accordance with the ethical guidelines of our institution and approved by the Dutch Committee on Research Involving Human Subjects (CCMO).

Study 1

Materials. The goal of Study 1 was to map negation use in Dutch-language PILs. To ensure comparability of PILs, we focused on PILs for drugs for one specific disease: pollinosis (hay fever). This is a common disease in the Netherlands. Prevalence figures for 2008 show that, on average, 37.0 out of 1,000 patients consulted their GP about complaints related to this disease.[24] In 2011, this had risen to 38.5 out of 1,000 patients.[25] Furthermore, different drugs for this disease can be obtained, some of which unrestricted (e.g., in drugstores) while others are only available with a physician prescription.

In the Netherlands, the PILs of every drug for human use must be registered at the *Medicines Evaluation Board* (*College ter Beoordeling van Geneesmiddelen*, CBG-MEB).[26] The online CBG-MEB database of human medicine contains the most recent version of every approved Dutch PIL.[27] To select PILs for drugs that are only available by physician prescription, we searched this database for drugs that contain an active substance found in anti-allergy medicine (e.g., *loratadine, levocabastine*) and were explicitly labeled as only available by physician prescription. For the freely-available drugs, we searched the online webshops of Dutch drugstore chains (e.g., *Kruidvat*, *Etos, Trekpleister*) for pollinosis drugs and subsequently downloaded the PILs for these drugs from the CBG-MEB database. After reading, we removed (almost) identical PILs (e.g., PILs for the same drug, but with a different dosage of active substances) and PILs for

drugs not exclusively targeting pollinosis. This resulted in a sample of 50 unique prescription-only and 23 unique freely-available drugs. We subsequently randomly sampled 15 PILs from each category, resulting in a corpus of 30 PILs.

To make sure that the studied texts were comparable, we focused on two sections that were available in every PIL: information about (1) proper usage and (2) potential side effects.

Coding procedure and reliability. To enable a reliable content analysis, we selected our unit of analysis; the so-called recording/coding unit.[28] In content analyses, the ideal recording/coding unit is the "smallest unit that bears all the information needed in the analysis"[28]. Since negations are often used in the context of propositions, we chose grammatical finite clauses as our recording/coding unit. A finite clause can contain only one finite verb (e.g., the word 'is' as in the clause 'something is not dangerous'), making it the smallest propositional grammatical unit.[29] One sentence can contain multiple clauses. For instance, the sentence "This is dangerous, because it can affect your heart" contains two finite verbs ('is' and 'can') and thus two clauses.[30] Coding negations on the level of finite clauses also enabled us to analyze the occurrence of 'double negations' (i.e., clauses with >1 negation). In total, our corpus consisted of 1,921 clauses (17,565 words).

Next, we coded each clause for negation use. We based our rules for negation identification on the chapter on negations from a grammar of Dutch (i.e., *elektronische Algemene Nederlandse Spraakkunst,* E-ANS).[21] We coded for both *syntactic* and *morphological* negations. Syntactic negations were classified in *explicit* and *implicit* negations. Implicit negations were further sub-divided into *mergers* and *other implicit* negations, following the division in the E-ANS, Table 29.1 (http://ans.ruhosting.nl/e-ans/29/02/02/body.html).

To measure intercoder reliability, a second coder coded a subset of 20% of the corpus (i.e., 6 PILs, 339 clauses).[31] Intercoder reliability scores (κ=.81) showed satisfactory reliability.

Data analysis. On average, PIL segments contained 64.0 clauses (*SD*=28.2). However, the number of clauses in a segment varied strongly across PILs (range: 27-147 clauses). To account for these differences, we aggregated the coding of clauses to PIL-segment level. This resulted in variables showing percentages and average number of clauses containing negations per PIL segment. As our corpus included 30 PIL segments and we compare two segment types (information about proper usage/ information about potential side effects), our aggregated dataset contained 60 cases. To test for differences in negation use, we successively entered the average number of the four coded negation types as dependent variables in 2x2 (M)ANOVAs with PIL type (freely-available/prescription-only) and segment (proper usage/side effects) as predictors.

Study 2: Effects of negations

Design and materials. Participants were randomly assigned to read a PIL section on proper usage of pollinosis medicine containing either negations or affirmations.[15,20] These versions were created using original PIL sentences from the corpus used in Study 1, following recommendations from literature to increase ecological validity of experimental materials.[32] Both versions contained identical information, except for the use of negations. The PIL with negations contained both explicit and implicit negations, while the other PIL only contained affirmations. In the original Dutch, the texts were 176 words (affirmations) and 200 words (negations) long (See Digital Appendix for materials).

Instrumentation. To measure *actual PIL comprehension*, we presented participants with 10 closed statements referring to information presented in the PIL. This way of measuring actual comprehension is based on previous research.[33-35] Participants indicated the degree to which they agreed with the recommendation (e.g., *Would you recommend taking the drugs after dinner?*) on 7-point semantic-differential scales, ranging from *1 = completely discommend* to *7 = completely recommend*. If participants gave the recommendation corresponding to the information in the PIL, the answer was coded as correct. If not, the answer was coded as incorrect. Neutral answers were also coded as incorrect. We subsequently calculated the percentage of correct answers.

All other dependent variables were measured with 7-point Likert scales, ranging from *1 = completely disagree* to *7 = completely agree*. *To* measure *perceived complexity,* participants indicated whether they thought the PIL was clear, easy and comprehensible (α=.95)[36]. We measured *perceived readability* by asking whether the PIL was easy to read, easy to understand and easy to remember (α=.92).[5] We tapped *appreciation of the PIL* by asking whether participants thought the PIL was well written, appealing and well succeeded (α=.93).[36] *Medical adherence intentions* were measured with a single item, by asking how likely they would follow the PILs instructions if they had to use the described drug (based on [33]).

Finally, we tapped which elements of PILs participants found important and presented them with 10 content elements they were asked to rate from *1 = very unimportant* to *7 = very important* (cf. Table 2).[37] We also asked participants to select the elements of PILs they would like to change by choosing their top 3 out of 12 options (cf. Table 3).[37]

Data analysis. To assess whether PILs with negations were evaluated differently from PILs with affirmations, we conducted independent-samples t-tests on the different dependent variables.

Subsequently, to test whether a reduction in medical adherence intentions could be attributed to objective and/or subjective measures of comprehension, we used the PROCESS macro to test for indirect effects with 5,000 bias-corrected bootstrap samples.[38]

Results

Study 1

On average, 21.0% of clauses in PILs contain negations (see Table 1 for descriptive statistics). Our analysis shows a main effect of PIL segment ($F(1, 56)=31.96$, $p<.001$, $\eta_p^2=.36$), indicating that information about side effects contains relatively more negations than information about proper usage. The main effect of PIL type ($F<1$) and the interaction of PIL type*segment ($F(1,56)=2.86$, $p=.097$) were non-significant.

Next, we compared the use of the different negation types. First, we observed only 16 morphological negations in total in the corpus, which was too low for proper comparisons. Next, we compared the three types of syntactic negations. Multivariate analyses reveal a main effect of PIL segment (Wilks' $\lambda=.40$, $F(3, 54)=27.30$, $p<.001$, $\eta_p^2=.60$) and an interaction effect of PIL segment*type (Wilks' $\lambda=.87$, $F(3, 54)=2.82$, $p<.05$, $\eta_p^2=.14$). We found no main effect of PIL type (Wilks' $\lambda=.99$, $F(3, 54)<1$). Subsequent univariate analyses revealed differences in PIL segments for the use of explicit negations ($F(1, 56)=43.08$, $p<.001$, $\eta_p^2=.44$), implicit-merger negations ($F(1, 56)=24.71$, $p<.001$, $\eta_p^2=.31$) and implicit-other negations ($F(1, 56)=17.93$, $p<.001$, $\eta_p^2=.24$). Compared to segments about proper use, PIL segments about potential side effects contain more explicit and implicit-other negations and less implicit-merger negations.

Furthermore, we also found significant interaction effects of PIL segment*type for explicit ($F(1, 56)=4.33$, $p<.05$, $\eta_p^2=.07$) and implicit-merger negations ($F(1, 56)=4.56$, $p<.05$,

η_p^2=.08), but not for implicit-other negations ($F(1, 56)<1$). Post-hoc analyses with Bonferroni corrections reveal that the differences in negation use between segments about proper usage and side effects are more pronounced in PILs for prescription-only drugs (both *p*-values <.001) compared to PILs for freely-available drugs ($p_{explicit\text{-}negations}<.01$; $p_{implicit\text{-}merger}=.05$).

Study 2

Sample characteristics. Participants were recruited online in various Dutch Facebook groups. Participation was unpaid and voluntary. A total of 109 people started, out of which 81 participants completed the questionnaire. One participant was dropped for not being a native Dutch speaker, leaving 80 participants (M_{age}=33.19 years; SD_{age}=13.66, 76.3% female). Most participants indicated that they often (21.3%) or always (46.3%) read their drugs' PILs. A total of 30.0% of participants suffered from pollinosis. The distributions of age ($t(74.75)=.68$, $p=.50$), gender ($\chi^2(1)=.000$, $p=.99$), frequency of reading PILs ($t(78)=.03$, $p=.98$) and suffering from pollinosis ($\chi^2(1)=.04$, $p=.85$) were equal across the two experimental texts (negations vs. affirmations).

General opinion of PILs. Table 2 shows that participants find almost all PIL elements very important. Elements related to storage, ingredients or physical appearance are considered less important than other content elements that mainly relate to proper usage or potential side effects of the drugs. Table 3 shows which elements participants would like to change. Results demonstrate that participants find three things most important as elements that can be optimized: (1) Giving the text a clearer table of contents, (2) Indicating important elements with bold or italic letters, (3) making the language more comprehensible. Furthermore, participants find comprehensibility more important after reading a PIL with negations (compared to affirmations, $t(79)=2.00$, $p<.05$,$r=.22$).

Effects of negations. Table 4 shows descriptive statistics. The PIL with negations (vs. affirmations) resulted in lower actual comprehension of the instruction information ($t(65.98)=2.44$, $p<.05$, $r=.29$), was found more complex ($t(78)=5.83$, $p<.001$, $r=.55$), less readable ($t(68.85)=5.40$, $p<.001$, $r=.55$) and appreciated less ($t(78)=4.47$, $p<.001$, $r=.45$). Finally, participants reading the PIL with negations indicated lower adherence intentions for the PIL's advice ($t(58.03)=3.08$, $p<.01$, $r=.37$). These results demonstrate that the PIL with negations scored lower on both objective (actual comprehension) and subjective measures (complexity, readability) of comprehension.

Results show that actual comprehension was not related to medical adherence intentions. However, we did find an indirect effect of negations on medical adherence intentions via perceived complexity and PIL appreciation (see Figure 1). This means that the effect of negations on medical adherence intentions is likely explained by these mediating variables. Negations increase perceived complexity, which, in turn, decreases PIL appreciation, which, in turn, leads to a decrease in medical adherence intentions (indirect effect = -.48, 95%CI=[-1.04, -.09]).

Discussion

For patients, PILs are an important source of information on proper usage of drugs. The present study focused on use and effects of negations in PILs. Study 1 shows that Dutch PILs for pollinosis drugs, to an equal extent in freely-available and prescription-only drug types, increasingly use sentential negations, as roughly 20% of clauses contain such negations. It is worth noting that more negations were used in PIL sections dealing with side effects compared to proper usage. As patients often have difficulties interpreting risk information in such information on side effects,[39-40] using negations with this information may further decrease

comprehensibility of the information. Study 2 showed the negative effects of negations in PILs, because PILs with negations led to reduced actual and subjective comprehension as well as lower PIL appreciation and medical adherence intentions.

Furthermore, it is important to focus both on actual and subjective comprehension in designing PILs. Actual comprehension is very important, because patients need to properly understand the information in PIL in order to correctly comply with requirements. However, actual comprehension was unrelated to the decrease in medical adherence intentions. Subjective comprehension is also important, because negations increase perceived complexity, which in turn decreases PIL appreciation, which subsequently decreases medical adherence intentions. Thus, when patients have the subjective feeling that a text is complex and hard to comprehend, they are less inclined to follow its recommendations. When designing PILs, it is recommended to both test whether patients can obtain and retain the communicated information from the text (actual comprehension), but also to make sure that comprehension requires little subjective effort.

Our results tie in with the existing literature on negations which shows how negations can change comprehension because, compared to affirmations, negations introduce concepts of opposite meaning.[15-16] The linguistics literature suggests that these effects are mainly found for sentential negations, which are the most commonly used negation types in PILs (Study 1), and less for morphological negations.[22]

Our results also have important implications for effective PIL design and tie in with a large body of literature highlighting the importance of patient-centered and evidence-based design.[5,41-43] When asked which elements of PILs they would want to improve, participants suggest elements related to the lay-out of the PIL and to language comprehensibility (Study 2).

Our results further support the notion that comprehensibility of PILs should require much attention, as using negations to present important medical information decreases both actual and subjective comprehension, and medical adherence intentions. Medical professionals involved in designing PILs should thus refrain from using negations as much as possible.

Currently, the EU has provided a set of guidelines aimed to optimize comprehensibility of PILs. Despite these guidelines, many current PILs still suffer from readability problems.[3-5] This study demonstrates that, even though such guidelines are clearly a step in the right direction, not every element related to comprehension is covered. This study has shown that negations are one important formulation aspect not covered by the guidelines, but still in need of attention of PIL designers.

Some caveats should be noted about our study. First, Study 1 is limited in that we content-analyzed PILs for only one specific drug (pollinosis medicine) from one specific country (Netherlands). Second, Study 2 employed an experiment in which respondents had to imagine using a specific drug. Future research could study whether our results also hold for PILs for different diseases written in different languages, and may use cross-sectional data to study effects on real patients. Empirical evidence suggests that the observed effects of Study 2 should generalize to other languages, as, in other contexts than PILs, negations have been found to impact reading in languages like English[20] and Hebrew.[11]

When our results are replicated for other languages than Dutch, the EU could consider amending the guidelines to also include negations. Furthermore, we hope that this research stimulates new studies aimed at uncovering other understudied linguistic variables in PIL design, thereby providing a richer picture of all elements that are important in determining the comprehensibility of PILs.

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Table 1

Description and mean use (and SD) of different types of negations in two segments (proper usage, potential side effects) of pollinosis PILs (Study 1)

	Freely-available drugs		Prescription-only drugs	
	Proper usage	Side effects	Proper usage	Side effects
% of clauses with at least one negation per segment	16.5 (7.0)	26.1 (16.1)	12.0 (3.7)	29.7 (9.4)
Average number of negations per segment (per 100 finite clauses)				
Morphological negations				
Negate word by adding prefix (e.g., *un*healthy)	.79 (1.84)	1.52 (3.53)	.13 (.52)	2.35 (3.95)
Syntactic negations				
1. Explicit negations				
Negations with no or not (e.g., *not* healthy)	7.22 (2.83)	14.47 (6.22)	4.31 (3.24)	14.43 (5.01)
2. Implicit negations - mergers				
Merges no + other word (e.g., *not* ever → *never*)	2.65 (2.45)	1.27 (2.25)	3.44 (1.73)	0 (0)
3. Implicit negations – other				
Implicitly negate alternatives (e.g., *only, hardly*)	5.87 (4.20)	19.44 (23.91)	4.52 (3.45)	21.99 (14.31)

Note. Numbers for morphological and syntactic negations indicate the average number of morphological and syntactic negations per 100 finite clauses.

Table 2

Mean scores (and standard deviations) of perceived importance of different elements of information included in PILs (Study 2).

	Perceived importance
What to use the drug for	6.39 (.70)[a]
What is in the drug	5.54 (1.30)[b]
Who can use the drug	6.37 (.75)[a]
What you can or cannot do when you use the drug	6.55 (.59)[a]
How much of the drug you are allowed to take	6.60 (.65)[a]
With what you should take the drugs	6.10 (1.07)[ab]
What possible side effects are	6.41 (.77)[a]
What you should do when side effects occur	6.32 (.87)[a]
How you should store the drug	5.88 (1.14)[b]
What the drug looks like	4.24 (1.81)[c]

Note. Perceived importance is measured on a 7-point semantic differential scale with higher numbers indicating higher perceived importance. Numbers with different superscripts (a,b,c) differ significantly with a certainty of at least $p < .05$.

Table 3

Score related to number of times the following suggestion was included in participants' top three of most important things to change in PILs (Study 2).

	Score
Giving the text a clearer table of contents	101
Indicating important elements with bold or italic letters	81
Making the language more comprehensible	80
Showing images with the text	39
Formulating the text more positively	33
More headers in the text	32
Give more information	30
Give less information (as the text is too long already)	25
Scaring people less with information about all potential side effects	17
More focus on the positive effects of the drug	13
Increasing the font size	8
Increase line spacing between bits of text	7
Use only black letters, not other colors	6
Printing the patient information leaflet on a larger paper size	1

Note. Mentioning an element as the most important (first place) generated three points, mentioning an element an second place generated two points and mentioning an element in third place generated one point. We also provided participants with the opportunity to not fill out this question if they did not want to change anything. One participant only filled in one thing they wanted to change. Four participants only mentioned two things.

Table 4

Mean scores (and standard deviations) of actual comprehension, perceived complexity, perceived readability, PIL appreciation and medical adherence intentions, in the language use (affirmations vs. negations) conditions (Study 2).

	Affirmations	Negations
Actual comprehension	44.21 (6.83)[a]	40.95 (4.84)[b]
Perceived complexity	2.62 (1.49)[a]	4.76 (1.76)[b]
Perceived readability	5.62 (1.16)[a]	3.74 (1.90)[b]
PIL appreciation	4.18 (1.41)[a]	2.70 (1.55)[b]
Medical adherence intentions	6.29 (.69)[a]	5.48 (1.55)[b]

Note. Actual comprehension is expressed in the percentage of correct recommendations given. The other variables are measured with 7-point Likert scales, with higher numbers indicating greater complexity, greater readability, more appreciation and higher intention to follow the PIL's advice. Means of variables with different subscripts (a, b) are significantly different with a certainty of at least $p < .05$.

Figure 1.

Mediation analysis with perceived complexity and PIL appreciation as hypothesized serial mediators of the effects of negations on medical adherence intentions (Study 2).